CLEVELAND FOUNDATION SURVEY

EDUCATION

THE METAL TRADES

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BY

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FOREWORD

This report on "The Metal Trades" is one of the 25 sections of the report of the Education Survey of Cleveland conducted by the Survey Committee of the Cleveland Foundation in 1915. Twenty-three of these sections will be published as separate monographs. In addition there will be a larger volume giving a summary of the findings and recommendations relating to the regular work of the public schools, and a second similar volume giving the summary of those sections relating to industrial education. Copies of all these publications may be obtained from the Cleveland Foundation. They may also be obtained from the Division of Education of the Russell Sage Foundation, New York City. A complete list will be found in the back of this volume, together with prices.

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INTRODUCTORY

Approximately one-half of the total number of persons in Cleveland engaged in manufacturing are found in the metal industries. When the last federal census was taken, nearly one-seventh of the entire male population was employed in establishments engaged in the manufacture of crude or finished metal products. Pittsburgh only, among the 10 largest cities in the country, has a higher proportion of its industrial population working in such establishments. In relation to its total population, Cleveland has twice as many people working in these industries as Chicago, three times as many as Philadelphia, and four times as many as New York. It is estimated that at the present time the number of wage-earners in the city engaged in this kind of work is between 70,000 and 80,000.

This report deals with the three leading industries of the city,—foundry and machine shop products, automobile manufacturing, and steel works and rolling mills. The study of this last group also includes several related industries, such as blast furnaces, wire mills, nail mills, and bolt, nut, and rivet factories. About three-fourths of the total number of wage-earners in the city engaged in the manufacture of metal products are found in these three industries.

The field investigations of the Survey consisted of personal visits to the manufacturing establishments for the purpose of securing first-hand data as to industrial conditions, and conferences with employers, superintendents, foremen, and workmen as to the need and possibilities of training for metal working occupations. In all, 60 establishments, employing approximately 35,000 men, were visited. The information obtained was carefully tabulated and these data form the basis of the discussions relating to working conditions and possible training presented in the following pages.

The conclusions as to vocational training are based on an analysis of educational needs in the various metal industries, together with an extended study of the social and economic factors which condition the training of all workers. Particular attention has been given to the administrative problems involved in such training in public schools.

THE METAL TRADES

PART I

FOUNDRY AND MACHINE SHOP PRODUCTS

According to the United States Census, foundries and factories making machine shop products gave employment in 1909 to nearly 18,000 Cleveland wage-earners. This industrial group ranks first in the city, employing more than twice as many workers as the next largest industry,—automobile manufacturing,—and approximately two-fifths of the total working force in all metal industries. Its growth during the previous five years, from the standpoint of number of workers employed, showed an increase of about 33 per cent, and if an equal rate of increase was maintained during the succeeding five years, the total number of wage-earners in 1914 was approximately 25,000. At the present time, due to the impetus given to this branch of manufacturing by the European war, the working force is undoubtedly in excess of this figure.

MACHINISTS

By all odds the largest group of skilled workmen in these industries is classed under the name of ma-

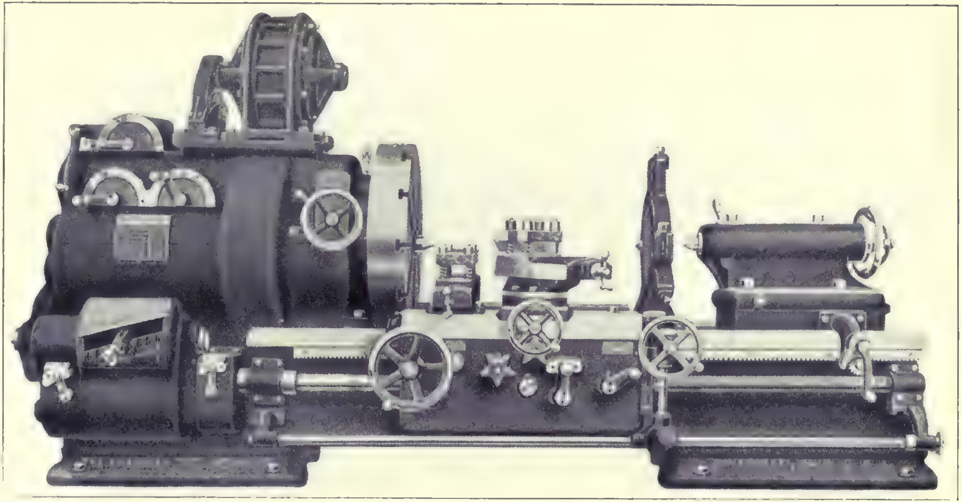
chinists. For this reason, considerable space will be devoted to the detailed study of this trade, taking up such matters as tools and processes, specialization, apprenticeship, promotion, organization, health conditions, and so on. These general conditions of labor will also be considered in connection with the smaller trades, but in less detail.

The machinist's work has to do in the main with giving a special shape, size, or finish to metal machine parts, and with assembling, testing, erecting, and repairing machinery. It involves a wide range of operations, most of which are performed with machine tools, that is, machines of various types fitted with tools made of special steels hardened sufficiently to cut metal. The shapes and sizes of these cutting tools vary according to the nature of the work to be performed.

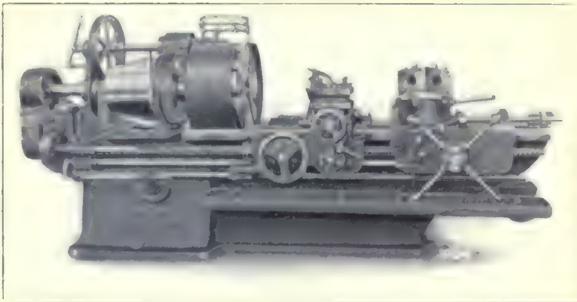
Tool and die making, which are subdivisions of the trade, call for a high degree of skill and an extensive practical knowledge of the working properties of iron and steel. The men who do this work must have a general knowledge of the machinist's trade, but in addition they require a considerable amount of special knowledge and skill relating to the designing, shaping, and sharpening of tools. The all-round machinist must know how to use all the machine tools of the trade, but usually he does not possess the special training and experience required in tool making.

Machine Tools Used in the Trade

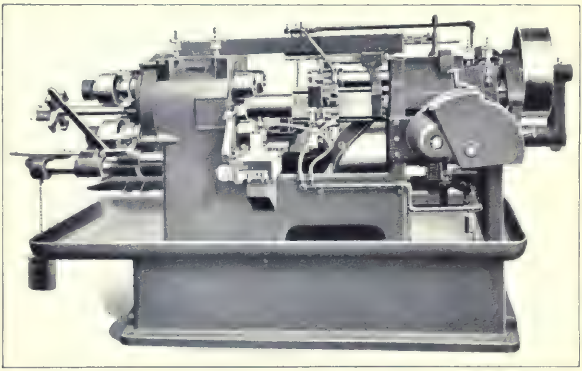
While each branch of manufacturing has a number of tools and machines especially designed to meet its



Large manufacturing lathe



Turret lathe



Multiple-spindle automatic screw machine

particular needs,—the equipment in the different factories varying according to the nature of the work, —there are certain kinds of machine tools which are indispensable in every first-class machine shop. Among the more important types used in modern manufacturing are lathes, planers, milling machines, grinding machines, and drilling machines.

The lathe is one of the oldest of machine tools and was developed from the potter's wheel. It is used for machining cylindrical surfaces and is by far the most important tool used in machine work. It is made in many sizes and forms, from the jeweler's lathe to the huge engine lathe for turning the propeller shaft of a battleship. In its simplest form, the hand lathe, the piece to be turned is mounted on a revolving spindle and the cutting tool held against the piece by hand. At the present time there is little hand turning in manufacturing work. The lathes commonly used are provided with tool holders which carry the tools and automatically move them along the surface of the revolving piece.

The turret lathe, developed from the ordinary lathe by the addition of a revolving tool-holding device called a turret, is used extensively. The faces of the turret, usually four or six, are made so as to hold tools of different kinds. When the operation to be performed by one tool is completed, the turret is automatically backed away from the piece and then given a part turn so as to move the next tool into position. After this tool has finished its work another one is brought into action, and so on until

the work is finished. The time formerly lost in changing and adjusting tools at the end of each operation is saved, while the work is done more accurately and in less time.

The automatic screw machine is commonly used in manufacturing, particularly when a large number of pieces of the same kind is required. In design and method of operation it is simply a highly developed turret lathe. In some types the turret, instead of being square or hexagonal, as in the turret lathe, is shaped like a drum. As each operation is completed, the drum, with the tools it carries, backs away from the piece and with a slight turn brings the next tool into position. This machine derives its name from the fact that it was originally designed for the manufacture of screws. Its possibilities in other lines of work were quickly seen, and it is now used in the manufacture of a great variety of small machine parts. Usually the raw material, or stock, as it is called, is fed to the machine in long bars or rods. When all the operations are finished, the piece is cut off by a cutting tool and the bar automatically moved forward into position for machining the next piece.

In some types of screw machines, called semiautomatics, the operator must remove each piece as completed and replace it with fresh stock; in others the machine works on a number of bars of stock at once with several tools cutting at the same time, each on a different piece. These machines, once set up and adjusted, require little attention except to

renew the stock. The men who set them up, lay out the work, plan the order of work, and so on, must be experts in every sense of the word. On the other hand, the runner or operator may be only a semi-skilled helper, for when the tools are once mounted and the speed and order of operation determined, the machine needs only to be kept supplied with raw material.

The planer is, after the lathe, the most important tool in the shop. As its name indicates, it is used for machining plane or flat surfaces. The piece is firmly secured on a flat bed or table which moves backward and forward under a stationary tool. It is the best tool for machining flat surfaces on heavy pieces, and is made in a great variety of sizes and styles. For light work on plane surfaces, a shaper is used. The principle of operation is the same as that of the planer, except that the tool moves while the piece remains stationary.

The milling machine is another tool which is very extensively used. It was originally developed in the manufacture of firearms, where its peculiar adaptability for the production of small parts with intricate profiles was early recognized. It is also used quite generally at the present time for finishing large cuttings. This work was formerly done with planers. The operating principle is the same as that of a circular saw. The machine is provided with one or more circular cutters having a number of teeth, or cutting edges, each of which removes a chip of metal from the piece as the cutter revolves. One of its principal ad-

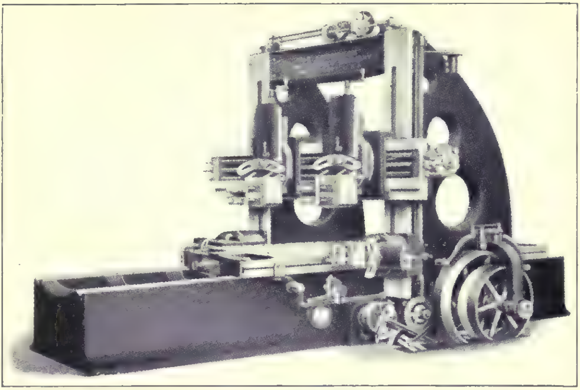
vantages is that it can finish duplicate parts of almost any shape so accurately as to make them interchangeable. It has a wide range of working capacity and is provided with graduated dials which permit of accurate adjustment to less than one-thousandth of an inch. For many years the milling machine was the only machine tool supplied with graduations for extremely fine adjustments.

The grinding machine is capable of finishing parts with even greater accuracy than the milling machine. The work is performed by a grinding wheel of emery, corundum, or carborundum. Only a slight thickness of metal is removed, the piece being first reduced to about the desired size on a lathe or milling machine and then finished by grinding. A shaft, for example, is turned in the lathe to within one-thirty-second of an inch of its proper diameter and then transferred to the grinder which brings it down to exact size, leaving a perfectly smooth surface.

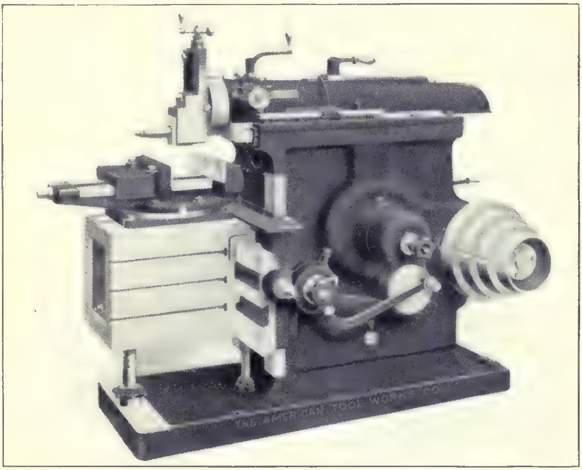
Drilling machines are used for boring holes in castings, plates, and machine parts, and are made in many forms and sizes, from small hand drills to huge boring mills for drilling castings weighing many tons. The apprentice usually begins his experience with machine tools on one of the smaller types of drill presses.

Largest Field of Employment for American Boys

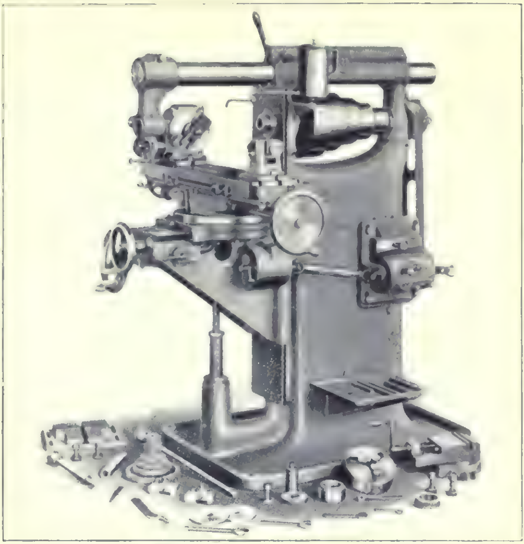
Comparisons with other manual occupations bring out in a striking way the importance of the ma-



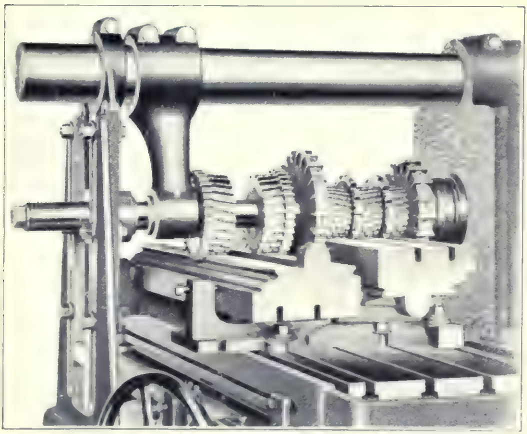
A planer



A shaper



Universal milling machine



Gang cutters milling two sides at once

chinist's trade. Nearly one-fourth of the city's industrial workers in the so-called skilled trades are classified under this name. About one and one-half times as many men are employed in machine work as in all the remaining metal trades, and more than half as many as in the combined building trades. Of still greater importance for the purpose of this study is the relative standing of the trade with respect to the opportunities for employment it offers American boys. It must be clearly borne in mind that many of the trades recruit a large proportion of their workers from Europe, and that hence the total number employed in a given occupation does not accurately indicate its size as a field of employment for the boys now enrolled in the public schools, of whom more than 90 per cent are native born. Next to machine work, molding gives employment to more men than any of the metal trades, but of every five new molders employed, four are imported from abroad. In the machinist's trade only about two in every five vacancies are filled by foreign labor. Compared with other skilled trades, the machinists are holding their own remarkably well against the incursion of European labor. The distribution of Americans among the principal trades in the city at the time of the last census is shown in Diagram 1.

The trades selected for comparison include all those employing over 400 Americans. Machine work offers nearly three times as many opportunities for employment to native born boys as any other re-

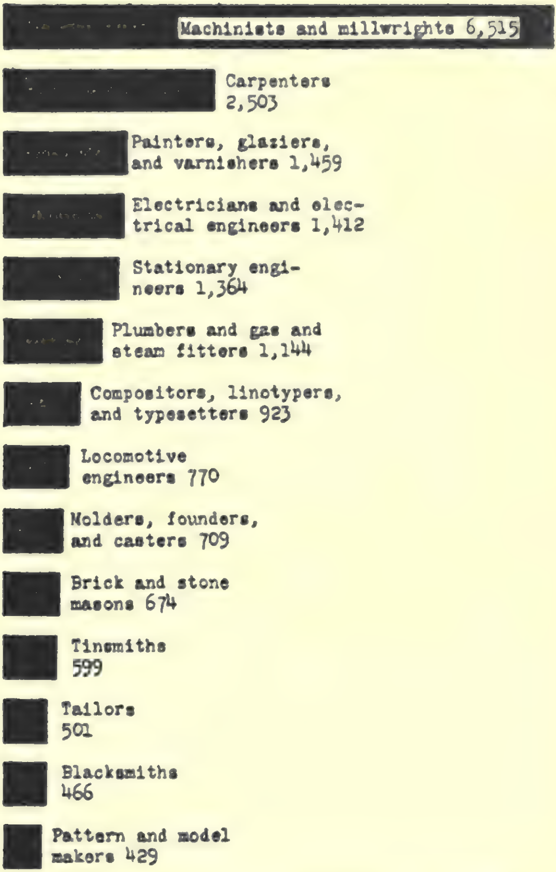
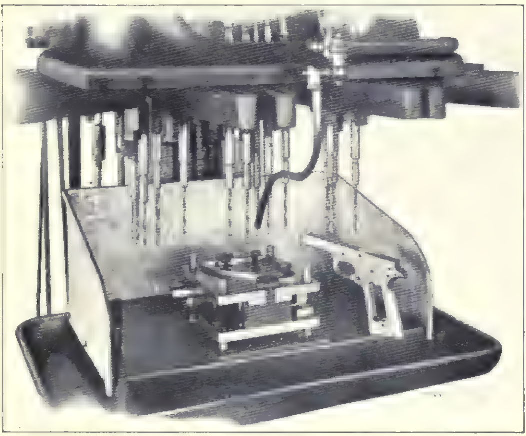


Diagram 1.—Distribution of Americans in the principal skilled trades in Cleveland, 1910

Surface grinder



Multiple-spindle drill operating upon automatic pistol frames

maining trade listed, and, leaving out carpenters, building painters, electricians, and stationary engineers, more than all the rest combined.

Trades Within a Trade

If a list of the best known manual occupations were submitted to a committee of lawyers, or teachers, or merchants with the request that they pick out the one requiring the highest skill, probably half of them would select the machinist's trade. Fifty years ago such a selection would have had much in its favor, and even today it can be sustained if we are considering only all-round machinists. At the present time not more than one man out of every four engaged in manufacturing or repairing machinery is a machinist in the usually accepted sense of the term. The table on p. 22, which lists the various machine tool occupations found in the establishments visited during the Survey, illustrates the manner in which this trade is subdivided under modern shop conditions.

The estimate of 18,000 as the total number of machinists in the city in 1915 is probably too low. Accurate data are not available. The relative proportion shown for each occupation is computed from exact data collected during the Survey, covering 4,500 men employed in machine tool work.

The tool makers and machinists, with a small proportion of the lathe hands and planer hands, are the only workmen listed in the table who possess an approximately complete all-round knowledge of the

TABLE 1.—PROPORTIONS AND ESTIMATED NUMBERS EMPLOYED IN CLEVELAND IN MACHINE TOOL OCCUPATIONS, 1915

Workers	Per cent	Estimated number
Lathe hands	18.8	3,384
Drill press operators	17.9	3,222
Bench hands	13.4	2,412
Machinists	12.7	2,286
Screw machine operators	9.4	1,692
Milling machine operators	8.6	1,548
Tool makers	8.3	1,494
Grinding machine operators	6.2	1,116
Planer hands	2.2	396
Turret lathe operators	1.8	324
Gear cutter operators	.7	126
Total	100.0	18,000

trade. Very few of the machine operators know how to operate more than one machine. Some of the bench hands are employed on difficult assembling and fitting jobs, where considerable skill is required. Other types of bench work call for little beyond the ability to use a few hand tools and follow simple directions.

Causes of Specialization

One reason for this subdivision of the machinist's trade into a number of separate occupations, each of which is to some degree a trade in itself, is the simplification of the work through the improvement of machine tools. This has decreased the need for the constant attention and individual judgment which were indispensable with the machines formerly used.

Another reason is the introduction of new methods of shop organization. The basic principle of modern shop practice is that a man who does only one thing will do that one thing better and more rapidly than if he does many things. Its application in factory organization has not only greatly increased the production per man and per machine, but has made possible the employment of a less skilled and consequently a cheaper type of labor.

Time Required to Learn

Inasmuch as no regular apprenticeship period is served for machine operating, a special effort was made to secure data relating to the time usually required for the worker to learn the operation of each tool well enough to earn average wages. In this matter the individual opinions of foremen and superintendents differed widely, but when the reports from all the establishments visited were compared, a sufficient degree of uniformity was found to serve as a basis for estimating the amount of experience workers of average intelligence would need, under normal shop conditions, in order to become fairly proficient.

There was practical unanimity in fixing the period at four years for tool makers and three to four years for machinists. Higher estimates were received from the superintendents of plants doing a jobbing business or manufacturing high grade machine tools than from the specialized shops making a single product.

The superintendents of automobile manufacturing plants, where the standard of quality in production is necessarily high, gave the lowest estimates of all. Table 2 shows the estimated time required to learn the various types of machine work.

TABLE 2.—ESTIMATED TIME REQUIRED TO LEARN MACHINE TOOL WORK

Workers	Time required
Grinding machine operators	12 to 15 months
Lathe hands	6 to 9 months
Planer hands	6 months
Gear cutter operators	6 months
Turret lathe operators	4 to 6 months
Screw machine operators	3 to 6 months
Bench hands	3 to 6 months
Milling machine operators	2 to 4 months
Drilling machine operators	2 weeks to 4 months

Apprenticeship

A few manufacturers in the city are endeavoring, with a fair degree of success, to restore the apprenticeship system to the position it once held in the machine trades. Most employers, however, have abandoned it, claiming that it "doesn't pay" and is too irksome and expensive. Many of them say that the boy of today is looking for a white-collar job, not for hard work, and lay the blame on the public schools where, they claim, the boy gets the idea that "success means sitting at a desk."

One manufacturer, who after repeated experiments has succeeded in organizing an apprentice class in his shop, stated his formula in the following terms: "My motto is, 'Catch 'em poor.' The first lot I tried looked

all right and for a short time everything went well. Then they began to drop out and fail to come to work regularly. I paid their tuition in the Y. M. C. A. continuation school, but before long I learned that they were cutting classes and that those who attended didn't take any interest in their studies. I finally got disgusted and gave it up. I kept thinking the matter over and a few months later decided to try again. This time I made up my mind I wouldn't take a boy whose family didn't actually need the money. Before he was accepted as an apprentice I had a personal investigation made and if it turned out that the family wasn't right up against it I refused to employ him. Most of them were the sons of laborers. The result was that I got a crowd who were mighty glad of the chance to rise above the common labor class and secured the co-operation of the parents who found the boy's wages a welcome addition to their income. This new crop of apprentices haven't any foolish notions, and I believe we can develop most of them into first-class mechanics."

The objection most commonly offered to the apprenticeship system was that the boys leave before the end of their term, and, as one employer put it, "There doesn't seem to be any good reason why we should train mechanics for other people." In many cases formal apprenticeship contracts are signed, but apparently they fail to impress either the apprentices or their parents with a sense of legal responsibility. The following "Agreement of Apprenticeship" is fairly representative of the form of contract generally used:

ORIGINAL

AGREEMENT OF APPRENTICESHIP

BETWEEN

AND

THE ______________________________ Co.

Cleveland, Ohio

....

Time to be served, 8,850 hours, divided into six periods of 1,475 hours each.

Wages for the first period	9 cents per hour
" " " second "	10 " " "
" " " third "	11 " " "
" " " fourth "	12 " " "
" " " fifth and sixth periods	15 " " "

The first 1,475 hours shall constitute a term of trial, the wages for that period to be 9 cents per hour. If at the expiration of that time, the said apprentice shall be found to be satisfactory, he will be given his apprentice card. If not found to be satisfactory, he will be discharged.

The ———— Company reserves the right to discharge said apprentice at any time for misbehavior or any other cause in their judgment detrimental to their interests.

The ———— Company reserves the right of reducing the number of hours of daily labor, when business depression or other causes demand such reduction, and will add the hours of compulsory idleness by reason of such reduction of working time to the hours of actual labor of said apprentice to be computed in the term of service as labor performed without remuneration.

The ———— Company to use all reasonable means to instruct said apprentice in the trade of machinist. The apprentice shall attend two or more machines, when they may be operated readily by one person, render any service in the line of said trade which may be required of him, and obey all regulations prescribed by said firm.

In event said apprentice shall serve the full term of 8,850 hours, he shall receive a gratuity of $100 but not otherwise.

All money becoming due said apprentice hereunder to be credited and paid to him direct on regular pay days.

THE ______________________________ Co.

by ______________________________

____

We consent to the foregoing ______________________________ Apprentice

____

Cleveland, Ohio.———19—. Guardian or Parents

The wages indicated in this agreement are those usually paid machinist's apprentices throughout the city, although there is no established rule. Some firms pay only seven cents an hour during the first or probationary period. Wages during the last period depend on the ability of the apprentice. The length of the apprenticeship period ranges from three to four years. One establishment visited requires all apprentices who have not completed a high school course to serve four years. Others require four years without regard to the previous training of the boy. Very few apprentices are taken under the age of 16.

As a rule, the apprentice runs errands about the shop, "chases stock," and serves as helper on light work during the first six months. He is then taught to run the drill press, and later on the milling machine. From six months to a year are devoted to lathe work, a somewhat shorter period to the planer, and several months to assembling, erecting, and bench work. There is no general rule as to order and method of instruction. A number of establishments send their apprentices to a day continuation school conducted under the auspices of the Young Men's Christian Association. Others require the boys to attend evening school classes for machinists in the technical high schools. The courses given in these schools will be described and discussed in another section.

Self-made Machinists

According to the statements of employers, a considerable proportion of the machinists in Cleveland

pick up the trade in repair and jobbing shops where they learn the different machine tools while employed as helpers. Some gain a general knowledge of the trade by working in various capacities in a number of different shops and then "bluff it through" as machinists in shops where they are not known.

Although an all-round knowledge of the trade can be obtained more quickly and more thoroughly by the apprenticeship method, the way is not barred to the boy whose economic situation demands that he earn as much as possible from the start. If he has no ambition to rise, he may, as commonly supposed, stick to a single machine all his life. But if he keeps his eyes and ears open and avails himself of every opportunity to widen his knowledge and experience, he can eventually master the technique of the trade without serving his time as a regular apprentice.

Apprenticeship at $7.00 Versus Specializing at $12.00

The greatest obstacle to the extension of the apprenticeship system is the high rate of pay for specialized machine work. After his first or second year at the trade the boy will have no difficulty, especially if he is physically well developed, in securing employment as a machine hand at from three to eight dollars a week more than he can earn as an apprentice. On piece work he may do still better. The bonus paid for completing the term of apprenticeship, amounting to from eight to 11 cents a day, is not a

sufficient inducement to hold him. He is quite certain to have friends of his own age, perhaps working in the same shop, who started in the trade by the machine operating route and who after a year or two of "specializing" on one machine, are making from $12.00 to $18.00 a week, while he receives but $6.00 or $7.00. It is not hard for them to convince him that he is foolish to go on working two or three years more for a pittance, when he can get a job at once that will pay him not much below journeyman's wages.

A comparison between the earnings of an apprentice during his three-year term and those of a machine operator starting at the same time and in conditions otherwise equal, is shown in Table 3. The

TABLE 3.—COMPARISON OF WAGES EARNED BY AN APPRENTICE WITH THOSE OF A MACHINE OPERATOR DURING A PERIOD OF THREE YEARS

	Earned by apprentice	Earned by operator
First year	$280	$399
Second year	339	615
Third year	443	786
Bonus	100	..
Total	$1,162	$1,800

wage balance in favor of the operator amounts to $638.00 for the three years. To a young man of 17 or 18 earning seven or eight dollars a week, a difference of over $200.00 a year is impressive. It may not involve actual privation, but it means that he is unable to "keep up his end" with his fellows, and if he has to contribute to the support of the family,

as most of these boys do, it is likely to have a strong influence on parental counsel when the question of apprenticeship versus machine operating is under discussion.

In considering the problem we must also keep in mind the fact that the boy's margin of future reward for working three years at low wages is comparatively small. It is generally assumed that he rapidly makes up the difference after he begins to earn journeyman's wages. The facts do not bear out this assumption. Suppose apprentice and machine operator both start at the age of 16, that their earnings for the first three years are as shown above, and that both continue thereafter at the union scale, the apprenticed boy earning the all-round machinist's rate of 35 cents an hour, and the machine operator the "specialist" rate of 30.56 cents an hour. When both are 25 years old their earnings for the whole period will be approximately the same. The amount earned by each of them during a period of nine years, counting from the date when both went to work, is shown in the following comparison:

	Boy starting as apprentice	Boy starting as machine operator
Earnings during first three years	$1,162	$1,800
Earnings during succeeding six years	6,000	5,260
Total	$7,162	$7,060

An adequate supply of skilled workmen depends pretty largely on the willingness of the manufacturers

to pay for it—in money, and time, and thought. If all-round American machinists are as badly needed as most employers allege, the shortage must be met as any other shortage of labor is met—by increasing the financial reward for the class of labor needed, or adopting better methods for training beginners, or both.

The Lowest Paid Trade in the City

The all-round machinist has to measure up to standards quite as high as those required in the majority of the skilled trades, as to both length of apprenticeship and technical knowledge, and yet a comparison based on wages shows him to be at the foot of the class. The union rates for 35 of the principal trades in Cleveland are shown in Table 4. Unskilled workers in the building trades, such as helpers and laborers, make more than machine operator "specialists," while average all-round machinists earn less than hod carriers and longshoremen.

There are few union shops in Cleveland, but the rates given in the table are fairly representative of the wages paid throughout the city. In the establishments visited, the average hourly earnings of operators, all-round machinists, and tool-makers were slightly lower than the rates given in the table. Table 5 shows the average, highest, and lowest rates per hour for all branches of the machine trades in the establishments from which data were collected during the Survey, with the per cent employed on piece work and day work. Piece work is common in

TABLE 4.—UNION RATE IN CENTS PER HOUR IN 35 OF THE PRINCIPAL SKILLED TRADES, CLEVELAND, 1915

Trade workers	Union rate
Structural iron workers	70.00
Stone masons	70.00
Bricklayers	70.00
Plasterers	68.75
Marble setters	68.75
Inside wiremen	68.75
Slate and tile roofers	67.50
Stone cutters	62.50
Steamfitters	62.50
Plumbers	62.50
Lathers	62.50
Carpenters	55.00
Cement workers, finishers	55.00
Composing machine operators	53.75
Stereotypers	50.00
Paperhangers	50.00
Painters	50.00
Lithographic pressmen	50.00
Sheet metal workers	50.00
Patternmakers, manufacturing shops	45.00
Horseshoers	44.44
Photo-engravers, book and job	43.75
Cylinder pressmen, one or two presses	41.67
Compositors, book and job	41.67
Coopers	41.07
Tool and die makers	**40.00**
Carriage and wagon workers	40.00
Molders	38.89
Coremakers	38.89
Cooks, chefs	37.88
Bookbinders	37.50
Metal polishers and buffers	36.11
Platen pressmen, five or more presses	35.42
Upholsterers	35.00
Boilermakers, manufacturing shops	35.00
Machinists, all-round men, manufacturing shops	**35.00**
Machinists, all-round men, railroad shops	**34.00**
Machinists, specialists	**30.56**

machine operating jobs and the relatively high earnings of machine operators are due partly to this fact. Less than one-third of the men in these occupations

work on a straight hourly or daily rate. Specialization has favored the adoption of the piece-work system and its use is rapidly increasing. Tool-makers and all-round machinists are paid by the hour or day.

TABLE 5.—AVERAGE, HIGHEST, AND LOWEST EARNINGS, IN CENTS PER HOUR, AND PER CENT EMPLOYED ON PIECE WORK AND DAY WORK, CLEVELAND, 1915

Workers	Lowest	Average	Highest	Per cent on piece work	Per cent on day work
Tool makers	25.0	39.0	50.0	..	100
Machinists	25.0	33.2	50.0	..	100
Planer hands	20.0	32.2	42.0	..	100
Grinding machine operators	20.0	32.0	50.0	70	30
Bench hands	17.5	29.6	45.0	48	52
Screw machine operators	17.5	29.5	63.8	79	21
Lathe hands	19.0	29.1	40.0	40	60
Turret lathe operators	25.0	29.0	47.5	80	20
Gear cutter operators	20.0	26.7	40.0	96	4
Milling machine operators	15.0	25.9	40.0	53	47
Drill press operators	15.0	23.5	35.0	35	65
Machinists' helpers	20.0	22.2	25.0	..	100

On the basis of weekly or yearly earnings, the trade makes a better showing. Work is steady throughout the year, and the time lost through unemployment on account of seasonal changes is slight. Also, as the usual working day is from nine to 10 hours, that is, from one to two hours longer than in the higher paid building trades, the difference in daily wages is really less marked than a comparison of hourly rates would seem to indicate.

Chances of Promotion

The proportion of men in the industry qualified to direct and supervise grows smaller every year. This

is due in part to the rapid growth of the industry and in part to its failure to provide an adequate training system for the non-commissioned officers of its working force. Many employers consider this problem more serious than the shortage of highly skilled workmen. One factory superintendent who was deploring the lack of trained men, when asked how many all-round machinists he had in the shop, replied:

"Well, I myself served my time at the trade and worked at it for a good many years. In addition I have one man who is a first-class machinist. The rest of them are specialists—lathe hands, milling machine operators, drill press operators, and planer hands. They're good men as far as they go. Most of them learned to operate their machines in this shop, and I wouldn't change my working force for any I've seen in the city. I must say though, if I had to get two or three new foremen tomorrow I don't know where I'd find them."

Another manufacturer, when asked whether he found it difficult to get good workmen, said: "Yes, and no. By advertising in the newspapers I can quickly obtain a surplus of competent experienced help, or at least men of the type that can be easily broken in at most of our work. On the other hand, the problem of securing foremen who have a thorough knowledge of processes and are also able to direct men, is increasingly difficult."

The modern specialized factory organization affords few opportunities for the development of all-round workmen capable of filling foremen's jobs.

It is also true that in such factories foremanship itself has been specialized. In the larger plants foremen are chosen more for their ability to handle men than for their technical and trade knowledge. A man may be an expert workman and yet lack the qualities indispensable in a successful foreman.

The success of a shop, or of a department in a factory, is gauged by the quantity and quality of the product it turns out. Although in theory the foreman is supposed to look after both, in many establishments the matter of quantity is taken care of by the piece-work and bonus system of payment. If the worker's earnings depend on the number of pieces he can finish in a day, he needs no vigilant eye to keep him at work. He is more likely to require a brake than an accelerator.

An automatic check for quality is often provided by the simplified measuring and adjusting instruments which have come into common use in recent years. Machine tools equipped with adjusting indexes graduated to the thousandth of an inch, together with "fool-proof" gauges, calipers, micrometers, and so on, have greatly diminished the chances of mistakes. The larger establishments also maintain separate inspection departments where a force of men do nothing but test the products for size, finish, and accuracy.

The foreman's work in such an establishment is limited in scope. His principal duty is to keep the machine-like shop organization going with as little friction as possible. There must be no shortage of

material, no clogging at any point on the route that the work follows through the shop, no interference between the work of different individuals, and no waste motion. He is an adjuster, teacher, and referee, rather than a boss. He must be courteous, just, and fair. He has little to do with standards of output, which are fixed by statistical and time-study methods, or standards of quality, which are fixed by the engineering department.

A cardinal principle of the new philosophy of shop management is that firing men does not pay. The foreman who wants to hold his job must get along with his men. One of the largest plants in the city keeps a careful record of the changes in the personnel of each department. Whenever they rise above a certain number, the foreman of the department is called on for an explanation. If he continues to show inability to maintain a stable working force, an investigation is made, and unless he can prove the existence of exceptional circumstances which justify frequent discharges and resignations among his men, he himself is removed.

Practically all the foremen in the shops visited had received an all-round training as machinists, and there are few opportunities for promotion open to men who have not a general knowledge of the trade. On the other hand, such general knowledge is only one of the requisites for advancement. Others are initiative, resourcefulness, tact, self-control, ability to get along with men, and a disposition to subordinate personal interests to the interests of the busi-

ness. To these should be added the quality of patience, for there must be vacancies before there can be promotions, and vacancies among the better positions are not frequent. Ten of the establishments visited, employing a total working force of over 5,000 men, reported but eight vacancies among foremen's positions over a period of one year. These same establishments had in their employ a total of 618 all-round machinists and tool makers. Assuming that only the machinists and tool makers were eligible for promotion, the mathematical chance per man of becoming a foreman during the year was about one in 77.

Trade Union Organization

Exact data as to the extent of union organization among the machinists of the city are not available. Very few employers treat directly with the unions. During the past year special efforts have been made to increase the membership of the local organizations, but the union is still far from being as strong as are those of the building and printing trades in their respective industries.

Health Conditions and Accident Risks

In general the trade involves few health risks. Some of the work is sedentary, but not more so than many kinds of clerical work. The sanitary conditions in most of the shops are very good.

Although there is always some risk of accidents in machine work, the trade must be classed among the less hazardous industrial occupations. Employers are giving increasing attention to the installation of safety devices. Carelessness on the part of workers or failure to follow instructions are responsible for a considerable proportion of the accidents that occur.

PATTERN MAKERS

The work of the pattern maker consists of building patterns for metal castings. Each pattern is a full-sized model of the piece to be cast, and is usually made of wood. The tools used are practically the same as those of other woodworkers, and the work has some points of resemblance to cabinet-making. Ability to read blue prints is an essential requirement of the trade, since a full size drawing must be made before each job is begun.

Pattern making ranks among the highest skilled trades in modern industry. Up to the present time it has been little affected by the tendency towards specialization, so marked in many industrial occupations. Few trades are more interesting or offer a greater field for originality and ingenuity. As each pattern is a new job, the work is devoid of the monotony which so often characterizes factory occupations.

The number of pattern makers increased rapidly during the decade 1900–10, and there are approximately 1,000 in the city at the present time. This is

one of the few distinctively American industrial occupations in Cleveland. In 1910 over 61 per cent of the pattern makers in the city were American born. Compared with the proportion of native labor found in other skilled trades, this is a remarkably large showing. The foreign element is largely composed of men who learned the trade in Europe and represents a higher type of artisan than is ordinarily found in those occupations which recruit largely from foreign labor.

This is one of the few trades in which the apprenticeship system still holds its own fairly well. Nearly every shop has its quota of apprentices. The apprenticeship term is five years, and the wages range from eight to 10 cents an hour for the first year, 13 to 15 cents for the second, 18 to 20 for the third, and 22½ to 25 for the fourth. As a rule, a bonus of $100 is paid at the completion of the term. The minimum entering age is 16 years.

Compared with other skilled metal workers, pattern makers earn high wages. The union scale is 45 cents an hour in manufacturing shops and 49 cents an hour in jobbing shops. Wages in the shops visited during the Survey ranged from 31 to 55 cents an hour, with an average of 44 cents. The usual working day is nine or 10 hours. The trade is not seasonal and a good pattern maker need not worry about unemployment, as the demand for highly skilled men is generally greater than the supply. Between 35 and 50 per cent of the men in the trade belong to the pattern makers' union.

Molding, numerically the most important of the foundry trades, differs radically from pattern making in several characteristics. It is even more distinctively foreign than pattern making is distinctively American. Of every 100 molders, founders, and casters employed in Cleveland in 1910, more than 80 were born abroad. The trade is being recruited to an increasing degree from immigrant labor, and this condition tends to become more marked through the reluctance of American boys to work in shops where most of their fellow-workmen are foreigners. It is estimated that the total number of molders in the city at the present time is approximately 3,500, of whom only about 700 are of American birth.

The molding process consists of packing damp sand about a pattern in such a manner that when the pattern is withdrawn a cavity called the mold is left in the sand. This mold is then poured full of molten metal which forms the piece to be cast. The work, for the most part, is dirty and heavy, and much of it must be done in a stooping position. Burns from the molten iron during the casting process are not infrequent. The better grade of work, on the other hand, is interesting and affords opportunity for the exercise of considerable skill. The time lost through unemployment due to seasonal fluctuations is comparatively small. The usual working day is nine hours. In the establishments from which wage data were collected the wage ranged from 28 to 50 cents an hour, averaging about 39 cents. The union scale is

38.89 cents an hour. Exact data as to the extent of union organization could not be obtained, but union officials estimated their membership at 2,000.

Very few apprentices were found in the establishments visited, although molders are supposed to serve an apprenticeship of from three to four years. A large number of the skilled molders in Cleveland learned the trade before coming to the United States. Several years of training and experience are required to make a first-class workman.

It is not easy to fix the line of demarcation between skilled molding and semi-skilled molding. As a result of the introduction of machines and special methods of manufacture, much of the work formerly done by journeymen molders is now performed by semi-skilled "hands," who pick up some knowledge of the trade by working a few weeks or months as helpers. This class of molders is rarely found in the jobbing foundries or where large work is done, but they abound in factories producing light castings in quantities. They constitute more than half the total number of men engaged in the trade, and are usually recruited from immigrant common labor. Semi-skilled molding is generally paid on the piece basis, earnings ranging from 20 to 37 cents an hour. The average for all the establishments visited during the Survey was 26.8 cents an hour.

CORE MAKERS

The core maker prepares the sand cores which are placed in the molds to make cavities extending

through the castings. The materials are the same as those used in molding, but in core making the pattern forms the mold in which the sand core is shaped—exactly the opposite of the molding process.

Good core making requires almost as much skill as the more difficult kinds of molding, although a greater proportion of core makers belong to the semi-skilled class. The work calls for less physical strength and endurance than molding. A few apprentices were found, but in the main the trade recruits from foreign labor. The apprenticeship period is from three to four years.

Approximately 1,500 core makers were employed in the city in 1915. About half of them are semi-skilled "hands" in factories that specialize in the manufacture of small castings. Sufficient knowledge of the trade for such work can be acquired in a few weeks. This type of core maker usually begins as a laborer and picks up an acquaintance with the trade while engaged in other tasks about the foundry. Wages for such work, usually paid on the piece basis, range from 20 to 33 cents an hour, averaging approximately 27 cents.

Skilled core makers earn from 35 to 45 cents an hour, averaging approximately 39 cents. The union scale is the same as for molders, 38.89 cents an hour. There is little fluctuation in employment.

BLACKSMITHS

The traditional blacksmith belongs to the past, except as he survives in small shops doing light repair

work and horseshoeing. In factories the machine has crowded him out. Gas furnaces, steam hammers, mechanical shears, drop forging machines, and electric and acetylene welding processes have replaced the forge, the sledge, the anvil, and the various shaping and cutting tools which are ordinarily associated with this trade. Hand work is steadily declining, and in manufacturing establishments we find, instead of blacksmiths, such semi-skilled workers as hammermen, welders, temperers, etc., each performing a distinct and independent part of the old blacksmithing process. Among the 35,000 employees in the establishments which furnished data to the Survey Staff, only 82 workmen were reported under this trade classification.

In 1910 there were in Cleveland, according to the census of occupations, 1,688 blacksmiths, employed chiefly in horseshoeing and repair shops. Of these, 1,222, or over 72 per cent, were of foreign birth. The fact that during the decade 1900–10 the number of Americans employed in the trade actually decreased more than nine per cent, although the total number of blacksmiths in the city showed an increase during the same period of over 15 per cent, indicates that the trade has practically ceased to recruit from the native population. At present the field of opportunity it offers to the American boy is very limited. The increase in the trade as a whole is less than one-third that of the general population.

No apprentices were found in the establishments visited. Superintendents and foremen estimated that

from two to four years' experience is required to learn the work well enough to earn average wages. Most of the men who become blacksmiths are common laborers who pick up a working knowledge of the trade as helpers. The wage data collected by the Survey shows a range of from 25 to 50 cents an hour, with an average of 33 cents. The usual working day is 10 hours.

BOILER MAKERS

Boiler making consists of cutting, shaping, and fitting plates to form boilers, funnels, and other parts of machines. In 1910 there were 595 boiler makers in the city, of whom 288, or approximately one-half, were Americans. The trade here is practically at a standstill. During the decade 1900–10 the number of boiler makers in the city increased less than five per cent, although the total population during the same period increased approximately 46 per cent. Assuming the same rate of increase for the past five years, the present number in the city may be estimated at about 610.

The trade is becoming more and more specialized, due to the increasing number of mechanical aids for performing the work. Formerly an apprenticeship of four years was deemed necessary to learn boiler making, but in several establishments that were visited the foremen estimated that a green hand could be broken in to do the specialized work they required in from a year to 18 months, although they admitted

that an all-round training could not be given in this time. As a usual thing apprenticeship means little more than service as a helper for a specified time. None of the plants visited took apprentices.

The union scale of wages is 35 cents an hour in manufacturing shops and 32.5 cents in railroad shops. The average rate in the establishments from which data were secured by the Survey Staff ran considerably less than this. The usual working day is nine or 10 hours.

The work is heavy and the young man who wishes to learn this occupation should have a strong body and strong nerves, as a boiler shop is one of the noisiest places in the world. The field for employment offered by the trade in this city is very limited.

OTHER OCCUPATIONS

In addition to the foregoing trades there are a number of semi-skilled occupations in the foundry and machine shop group of industries, some of which are so closely allied with those already described that a separate description of them is unnecessary. Sheet metal work in factories, for example, has many points in common with boiler making. The workers belong to the same union and earn about the same wages.

A considerable number of men are employed as riveters in shops manufacturing plate metal products. This work requires a certain degree of manual skill which can be acquired only through practice. Riveting is heavy work and demands, more than anything

else, strength and endurance. It pays from 25 to 35 cents an hour.

Several hundred men are employed as polishers and buffers. The better grades of work call for considerable manual dexterity, although a large majority of the men employed in these occupations are semiskilled hands. Wages range from 25 to 30 cents an hour.

In 1914 the total number of women wage-earners employed in the "foundry and machine shop products" group of industries was less than 400, according to the report of the Ohio Industrial Commission for that year, or about two per cent of the number of men employed. They are usually engaged in packing and wrapping small finished products or in minor machine operating. The work is relatively unskilled and is usually paid by the piece. Earnings range from 15 to 20 cents an hour.

THE PROBLEM OF TRAINING

The problem of vocational training for the skilled occupations in this group of industries has to do with four groups: first, boys who are still in school but expect to follow a given trade and wish instruction relating more or less directly to it; second, boys who, after leaving school, have entered into agreements to serve a certain number of years as apprentices in order to learn the trade; third, young men employed as helpers or machine operators; and fourth, journeymen machinists. Each one of these groups of

people constitutes a separate educational problem, partly because their needs are not the same, and partly because of the difference in the conditions under which vocational training adapted to meet their varying requirements may be practicable.

The Boy in School

Let us consider first the case of the boy who is still in school, but will later enter one of the metal trades. There are at the present time between 500 and 600 such boys enrolled in the seventh and eighth grades of the public schools of Cleveland. By far the greater number of these will leave school at the end of the compulsory attendance period and enter the trades as apprentices, helpers, or machine operators. An investigation covering 3,000 boys at work in Cleveland, conducted by the Survey in the spring of 1915, showed that less than eight per cent of those working as machinists, apprentices, and machine operators had received any high school training, and that 57 per cent did not get farther than the end of the seventh grade. Less than three per cent had attended high school as much as two years, and none were high school graduates. The advantages of the technical high school course as a preparation for these trades are beyond question, but as a rule the type of boy who becomes a journeyman mechanic will not or cannot remain in school longer than he is compelled to by law.

Another fact that must be taken into account is

that most of the boys who enter these occupations are retarded, that is, one or more years behind grade. In theory all pupils who begin when they are six years old should have one year in high school before leaving school. In other words, if all pupils finish a grade a year from the time they start until they are 15 years of age,—the end of the compulsory attendance period,—most of them would finish the eight-year elementary course and one year of high school. As a matter of fact only two-fifths reach high school, for the reason that many take the full nine years of their school life to finish eight, seven, and in some instances only six, grades of the elementary course. It is mainly from this class that the industrial occupations are recruited.

What the boy who is going to leave school at the end of the compulsory period most needs is a complete elementary education. This does not mean that the present course of study is incomplete, but that it is not completed. Many pupils either do not reach the grades in which a beginning in vocational training might be made, or they stay in them so short a time that little or nothing can be accomplished. They reach the seventh grade at 13 or 14, one or two years behind grade, tired of school and anxious to quit as soon as the law will permit. Vocational courses are not a remedy for this condition. The pupils begin to fall behind in the third grade, and it is at this point that the cure of retardation should begin. Vocational training cannot undertake the job of bringing backward boys up to grade.

The kind of special educational training that will best meet the future needs of boys who are later going to be machinists, molders, pattern makers, blacksmiths, or boiler makers depends to a considerable degree on what is likely to happen to them when they go to work. Those who become apprentices will first have to undergo a trying-out process, usually covering from three to six months, during which time they run errands, chase tools, and make themselves generally useful. The purpose of this is to enable the employer to find out whether the boy is industrious and intelligent enough to warrant the further investment of time necessary to teach him the trade. The things that count most at this period are willingness to do as he is told, care and intelligence in carrying out orders, the reasons for which he will not always understand, and perseverance in sticking to unpleasant or uninteresting jobs until they are finished. The ideal apprentice was described by one employer as "wide-awake, intelligent, careful, industrious, and obedient." Assuming that he passes the tests of the probationary period, he is next taught to perform one of the simpler operations or to run a machine. In the machinists' trade he will learn in succession a number of machine tools, and spend from six to 18 months at bench work and assembling. About the same procedure is followed in pattern making shops. In the blacksmithing and boiler making trades he must begin as a helper, at a somewhat more advanced age than as a machinist's or pattern maker's apprentice. In molding and core making

he will be put on small molds or cores and given opportunity to take up the more difficult and complicated processes as he shows the ability.

As a rule, little is provided beyond the opportunity to learn through experience and observation. Specialization and the piece-work system leave the workmen but little time to devote to direct instruction of apprentices, and such instruction as is given usually aims to teach the boy how to perform a specific operation required for the job in hand, rather than to give him a broad understanding of trade processes. He learns the "how," but not the "why" of it. Under modern shop conditions the apprentice is taught a good deal about doing things, but very little about understanding them, chiefly because the head work of the industry is more and more centralized in the office and drafting rooms, leaving the hand workers in the shop only the task of carrying out simple, predigested instructions.

We need not enter here into a discussion as to whether or not this condition is inimical to the interests of the workers. The fact is that it exists and all the evidence goes to show that it will exist in still greater measure in the future. Its significance for vocational training lies in the fact that more than ever before both apprentice and workman are cut off from those aspects of their work which might give them some knowledge of the principles on which are based the various operations they perform. To impart a general understanding of these principles

should be the fundamental purpose of vocational training courses.

What the Schools are Doing

Neither the present elementary course nor the junior high school course adopted this year in two schools includes vocational work. The elementary course provides about 50 hours a year of manual training in wood work in the seventh and eighth grades. It is the familiar type of manual training with little vocational significance for any trade but cabinet-making. Further consideration of it may therefore be omitted at this point.

Mechanical drawing, of prime importance in nearly all the metal trades, does not appear in the elementary course of study, although a little time is devoted to it in the manual training classes of the seventh and eighth grades. The junior high school course gives one hour a week to this subject during the first and second years.

The course in the larger of the two technical high schools, the East Technical, includes shop work in joinery and wood-turning during the first year, and in pattern making and foundry work during the second year. In the West Technical High School the first year course includes pattern making, and either forging or sheet metal work; and that of the second year, forging, pipe-fitting, brazing, rivetting, and cabinet-making. During the remaining two years of the course the student may elect a particular trade,

devoting about 10 hours a week to practice in the shop during the last half of the third year, and from 11 to 15 hours a week during the fourth year. Four and one-half hours a week of mechanical drawing are required during the first and second years. These schools are equipped for practical work in four metal trades—machine work, molding, pattern making, and blacksmithing. Each school maintains an employment department and both report that they cannot supply the demands of employers for trained workers. Graduates can place themselves advantageously in the manufacturing establishments of the city, in some of which a reduction in the apprenticeship term is made to boys who have specialized in trade work a year or more at school. With respect to the trade courses elected, the third and fourth year classes during the first semester of 1915–16 were distributed as shown in Table 6.

TABLE 6.—DISTRIBUTION OF THIRD AND FOURTH YEAR CLASSES IN TRADE COURSES IN THE CLEVELAND TECHNICAL HIGH SCHOOLS, FIRST SEMESTER, 1915–16

Trade	Students
Electrical construction	68
Machine work	52
Printing	28
Cabinet-making	22
Pattern making	12
Foundry work	1
Total	183

Most of these boys will not be journeymen workmen, at least not for any considerable length of time, if the

occupational status of the classes graduated in the past can be taken as a guide. The principal of the East Technical High School recently sent a questionnaire to all the students graduated up to 1915, asking for information as to their present occupations. Of those who replied, over 60 per cent were either attending college, or employed as draftsmen or chemists. Only 28 per cent were working at skilled trades. Table 7 shows the distribution in detail.

TABLE 7.—DISTRIBUTION BY OCCUPATION OF CLEVELAND TECHNICAL HIGH SCHOOL GRADUATES

Occupation	Number
Attending college	111
Draftsmen	51
Electricians	33
Machinists	32
Chemists	8
Pattern makers	7
Cabinet-makers	6
Printers	3
Foundrymen	1
Unclassified	32
Total	284

The technical high schools are primarily training schools for future civil, electrical, and mechanical engineers. To students who cannot afford a college course they give excellent preparation for rapid advancement to supervisory and executive positions, and for drafting and office work in manufacturing and mechanical industries. Even if all who specialize in the metal trades were to become journeymen artisans, the total output per year would form but an

insignificant contribution to the quota of new men required in the industries of the city. It is most unlikely, however, that many of the students will be engaged in manual work five years after graduation. The complete course gives them an equipment of practical and theoretical knowledge which speedily takes them out of the hand-work class.

Only one molder was reported among the 284 graduates who gave information in 1915 as to their present employment. The number working at pattern making was relatively larger than in any of the metal trades. No graduates reporting were employed as blacksmiths, core makers, or boilermakers.

Difficulties of Vocational Training in Elementary Schools

The facts presented all point to the conclusion that under present conditions little can be expected in the way of trade training from the technical high schools. The reasons for this are that most boys who enter industrial occupations either go to work before they enter high school, or else remain in high school only through one or two years, and the shop work now given during those years has little relation to any but the smaller trades. Vocational training intended to reach any large number of these boys must begin not later than their 14th year.

A large proportion of the boys of this age are found in the seventh and eighth grades of the elementary schools. For administrative reasons, however, voca-

tional training in elementary schools is next to impossible. The total number of boys in the upper grades of the average elementary school who will later enter the skilled trades is too small to warrant special equipment and the employment of special teachers. The average elementary school in Cleveland enrolls between 700 and 800 pupils. Of these, about half, or let us say 375, are boys, of whom about one-sixth, or between 60 and 70, are enrolled in the seventh and eighth grades. How many future metal trades workers does a group of this size contain? We cannot tell exactly, but we do know that not all of them will enter these trades, because the same group of boys must also furnish the recruits for professional and business pursuits and for other industrial trades. In fact, the distribution of the adult male working population of the city indicates that the number that will enter the professions or take up some form of business or clerical work is almost as great as the number that will become industrial workers.

Our best guide in this matter is the occupational distribution of the city's native-born adult male population, as about seven-eighths of the boys in the public schools are of native birth, and it is highly probable when they grow up they will earn their living in the same kinds of work in which native-born men are now engaged. According to the federal census, the adult American wage-earners between the ages of 20 and 45 employed in skilled work in the metal trades constitute slightly less than 10 per cent of all the native-born men in the city between these

ages. It may be safely assumed, therefore, that the number of boys now in school who will enter these trades form about the same proportion of the total. If this is so, and the facts appear to admit of no other conclusion, a course of vocational training designed to benefit the future metal trades workers in this group of 60 or 70 boys would reach only six or seven boys.

The Junior High School

The junior high school plan offers more hopeful prospects, for the reason that it concentrates in relatively large groups the boys who are old enough to make a beginning in vocational training. The Empire School, the larger of the two junior high schools now established, has an enrollment of about 400 seventh and eighth grade boys. Applying the proportions of the occupational distribution of the adult male population, we find that approximately 28 of these boys are likely to become machinists, three molders, two pattern makers, three blacksmiths, and one a boiler maker. We may assume that when the junior high school plan is adopted throughout the city and the ninth grade is added, the enrollment will increase. It is not likely, however, to go much beyond 1,000 pupils per school. Such a school would enroll about 500 boys. Among these 500 boys there would be approximately 37 future machinists, four molders, three blacksmiths, two pattern makers, and two boiler makers. It is at once evident that for administrative reasons shop training directly related to

these trades is not practicable, except perhaps for the machinist group. The teaching cost for classes of two, three, or four boys would be prohibitive, to say nothing of the other items of expense.

Naturally the courses must take into account the general needs of the whole industrial group. In the report, entitled "Wage Earning and Education," the problem of vocational training in junior high schools is taken up from this point of view and the conclusion is reached that only a general industrial course is administratively feasible. In considering the special needs of the metal trades we may indicate, however, the subjects which such a general course should include.

First in importance comes applied mathematics. If every boy who is likely to enter the metal trades could, before he leaves school, be taught how to apply to concrete problems the arithmetic studied in the eighth year elementary course, about two-thirds of the work now demanded in apprentice and journeyman classes for these trades would be unnecessary. It is not that the elementary school fails to teach fractions, percentage, proportion, and mensuration, but that the pupil does not learn how and when to use these tools of knowledge for the accomplishment of practical ends.

A machinist's apprentice might be taught many things about the file. He might learn to distinguish at sight each one of the 100 or more varieties of files used in working metals, and learn to describe the characteristics of each type of file and give its name;

in fact he might become an expert on files, and yet, when called on to do a job of filing, not know which file was best adapted for the job nor how to use it. This is what happens with respect to much of the arithmetic taught in the schools. One employer cited the case of an apprentice who was recommended as "very bright" by his teachers, but when told to cut a bar eight and one-half feet long into five pieces of equal length, did not know how to lay out the work. He had been provided with the right tool for the job, but was unacquainted with its uses. The employer gave this instance as an illustration of what to his mind constituted one of the principal defects of public school teaching. "Mere knowledge of mathematical principles and the ability to solve abstract problems is not enough," he said. "What the boys get in the schools is mathematical skill, but what they need in their work is mathematical intelligence. The first does not necessarily imply the second."

The chief value of shop work for boys who are going into the metal trades is as a medium for developing this kind of mathematical intelligence—the ability to think in quantitative terms about problems which concern the relations of mechanical movements and laying out and shaping metal or wood. Incidentally it should give the pupil an acquaintance with materials and some manipulative skill in the use of tools, but if these were the only kinds of benefits to be derived from a shop course, the amount of time and money invested in it could hardly be justified on the basis of educational returns.

The equipment of the Junior High School should include a small machine shop, provided with a sufficient variety of machine and hand tools for teaching the principal operations performed in working metal. In a school of 1,000 pupils the number of boys who will eventually enter the machine trades alone is large enough to warrant the installation of a fair-sized metal working equipment.

In the shop classes a considerable amount of time should be devoted to taking apart and assembling machines. The general familiarity with mechanical principles obtained through such work is of the greatest value to boys going into these trades, and may well form part of the general shop work course for all the pupils. Assembling processes, with their attendant problems of adjustment and coördination of mechanical movements, afford opportunities for the best kind of practical instruction. One advantage of this type of shop work is the fact that it consumes no material; another is that a fairly extensive equipment can be easily obtained, as any machine, old or new, will serve the purpose and may be used over and over again.

The shop work should also be utilized to give the pupils a practical knowledge of industrial physics. The average workman can get along without a thorough course in physics, but he does need to know certain facts of physics and their relation to metal work. The instruction in this subject should be in the proportion of several parts of application to one of theory.

Much more time should be devoted to mechanical drawing than at present. The Junior High School course offers one hour a week in this subject in the seventh and eighth grades. For boys who expect to enter the metal trades no subject, except perhaps applied mathematics, is more essential. To the first-class machinist, pattern maker, and boiler maker the ability to understand and interpret plans and sketches is indispensable. Without this ability he is not likely to advance very far beyond purely routine work.

But here again, just as in the shop work, the emphasis should be on understanding drawings, rather than on fine workmanship in making drawings. As a rule, the journeyman machinist is not called on to make plans or designs, beyond perhaps an occasional rough sketch, but he must constantly work from drawings. This means that he needs at least a reading knowledge of what may be termed the graphic language of industry, while a writing knowledge of it, although of considerable advantage, is not absolutely essential. The controlling purpose, which is to give the pupil familiarity with the application and uses of drawing in industrial work, should be kept in mind throughout the course.

There are many outside aids at the command of the wide-awake teacher which ought to be utilized to the fullest extent. The public library contains a variety of books relating to machinery and to manufacturing processes, written so as to be understood by the average 13- or 14-year-old boy which can be

suggested for supplementary reading. Trade journals and such magazines as "Popular Mechanics" and "The Illustrated World" often contain pictures and short articles that can be used to bring home to pupils the close connection between the work of the schoolroom and the fascinating realms of invention and science. The ultimate value of classroom experience and study will depend on the extent to which it is related to the outside world of mechanical achievement and progress.

Lastly, all boys who are expecting to leave school at the end of the compulsory period should devote some time to the study of economic and working conditions in commercial and industrial occupations. A course of this kind would take up such factors as wages, steadiness of employment, health and accident risks, opportunities for advancement, extent to which the different trades are organized and what labor unions stand for, apprenticeship conditions, entrance requirements in the various trades, and the relative chances there are of getting into them.

It is safe to say that not one-half of the boys who enter industrial occupations in Cleveland do so as the result of a conscious selection of their own or of their parents. They drift into their jobs aimlessly and ignorantly, following the line of least resistance, driven or led by the accidents and exigencies of making a living. They leave school at 14 or 15 with little or no knowledge of industrial conditions from which to make an intelligent choice. There is no foundation for the current theory that an acquaintance with

materials and processes provides a sufficient basis for vocational selection. It does not take into account the fact that all these trades are primarily ways of making a living and only incidentally a means for the satisfaction of individual tastes.

The data contained in the various industrial studies made during the present Survey constitute a good foundation for a course of this kind. But industrial conditions change rapidly, and the course will soon be out of date unless the teachers keep in close touch with local sources of information. At the expense of a little time and trouble the teachers can establish relations with the labor unions and the local employers that will enable them to check up their data from year to year. Other sources of information are the yearly reports of the State Industrial Commission, the bulletins of the Federal Bureau of Labor, and the annual reports of labor unions.

A Two-year Vocational Course Needed

At the present time the law permits boys to leave school from one to two years before the world of industry has any use for them. Only a small number of the establishments visited during the Survey had any boys in their employ under 16 years old and very few of the skilled trades admit apprentices below this age. As a result of this condition the average boy who leaves school at 15 spends a year or two loafing or working at odd jobs before he can obtain industrial employment that offers any prospect of advance-

ment. This time is often wasted, because the boy not only fails to learn anything from such casual employment, but he misses the healthy discipline of steady, orderly work which is of the highest importance during these formative years of his life. Present conditions of employment demand that the compulsory attendance period for boys be extended to the age of 16.

The school authorities should seriously consider whether the subjects at present taught in the first and second years of the high schools are of the kind which will result in the greatest good to the large number of pupils who go to work at 15 and 16. It is not a question of whether the instruction now given is good for the pupils, but of making the most of the limited time they will remain in school. The eighth grade boy who will stay only one more year in school will undoubtedly obtain some benefit from the study of modern or ancient languages, but either mechanical drawing or applied mathematics will yield him much greater financial returns for the time invested. Instruction that will be of practical value to them for future wage-earning is what boys who expect to enter industrial occupations most need at this period. It is doubtful whether high school courses which have been formulated primarily to prepare pupils for a college course can furnish such instruction, and it is still more doubtful whether the trade training required by the future mechanic and the broader preparation required by the future engineer can be given simultaneously in the same school.

In the opinion of the Survey Staff, a better plan

would be to establish a separate two-year vocational school, equipped for giving preparatory training for all the larger industrial trades. Such a school, open to boys 14 years old and over, would fill the gap now existing between the end of the compulsory period and the entrance age in the skilled trades, and would provide at least a year of trade preparatory training before the boys go to work. A course of this kind would hold in school for an additional year many boys who now drop out at the end of the compulsory period, and thus enable them to secure a knowledge of trade theory which they will have little opportunity to obtain after they become wage-earners.

The number of boys in the public schools between the ages of 14 and 16 who are likely to enter the metal trades is between 700 and 800, of whom from 500 to 600 will become machinists or machine tool operators. An enrollment of much less than this number is sufficient to justify the installation of good shop equipment and the employment of a corps of teachers who have had the special training necessary for this kind of work. It should be possible to form a class in pattern making and foundry work of from 80 to 100 boys, and one of at least 30 in blacksmithing. Boiler making could be taught in connection with sheet metal work.

The details of organization and course of study in a school of this type are more fully discussed in the summary volume of the industrial education reports from the viewpoint of the whole industrial trades group. Naturally the course for any particular trade

will depend on the general plan adopted. It will be evident from the facts already presented that a very large proportion of the students—more than one-third—will require instruction relating to the machinist's trade. The school should endeavor to give every boy who is preparing to enter this trade an all-round knowledge of shop practice and the application of mathematics and drawing to machine work. Intensive training in the operation of one or two machine tools would be of more benefit from the standpoint of immediate wage-earning, but in the long run a general knowledge of trade theory will be a greater economic asset to the future worker. The principal subjects of the course have already been indicated in the discussion of the industrial course in the junior high school. They should be closely related to the trade selected by the pupil during the last year of the vocational course.

Trade-extension Training for Apprentices

The only trade-extension training for apprentices now offered by the school system is found in the evening classes of the technical high schools. The night school year comprises two terms of 10 weeks each, the pupils attending four hours a week, or a total of 80 hours for the year. The schools collect a fee of $5.00 a term from each pupil, of which $3.50 is refunded to those who maintain an average attendance of 75 per cent during the term. Apprentices, machine operators, helpers, and journeymen machinists all attend the same classes.

A questionnaire sent out by the Survey Staff in January, 1916, brought replies from 123 metal trades' apprentices, enrolled in different night school courses at that time. Of these, 80 were learning machine work, 36 pattern making, five core making, one molding, and one blacksmithing. Their distribution among the various courses is shown in Table 8. The two principal shop courses—machine work and pattern making—enroll over one-half of the total number. Approximately one-third are taking mechanical drawing courses.

TABLE 8.—DISTRIBUTION OF METAL TRADES' APPRENTICES IN THE EVENING COURSES OF THE CLEVELAND TECHNICAL NIGHT SCHOOLS

Course	Machinists' apprentices	Pattern makers' apprentices	Core-makers' apprentices	Molders' apprentices	Blacksmiths' apprentices	Total
Mechanical drawing	32	12	1	..	..	45
Machine shop	35	1	..	..	..	36
Pattern making	2	16	3	..	..	21
Foundry	1	6	1	..	..	8
Chemistry	2	..	..	1	..	3
Mathematics	3	..	..	..	..	3
Electrical wiring	2	..	..	..	1	3
Cabinet-making	1	1	..	..	..	2
Business English	1	..	..	..	..	1
Electricity	1	..	..	..	..	1
Total	80	36	5	1	1	123

The most discouraging feature of the night school work carried on at present is the fact that the boys attend the school for so short a length of time. The returns show that only 23 per cent had attended more than one term previous to the present term. The

average amount of time attended by all pupils was 88 hours, an equivalent of about 18 full school days.

Undoubtedly the best plan of trade-extension instruction is the one that is now in operation in a few manufacturing establishments of the city, where special teachers have charge of the supplementary training of apprentices. The best examples in Cleveland of this type of apprentice school are those conducted by the Warner and Swasey Company, manufacturers of machine tools and astronomical instruments, and the New York Central Railroad shops.

The Warner and Swasey Company school was established in 1911. The course of instruction covers a total of 560 hours, extending over a period of four years. The apprentices attend four hours a week for 35 weeks each year. The time allotment for the various subjects included in the course is shown in Table 9.

TABLE 9.—TIME ALLOTMENT IN THE APPRENTICE COURSE GIVEN BY THE WARNER AND SWASEY COMPANY, CLEVELAND

Subject	Hours
Arithmetic	35
English	65
Mechanical drawing	70
Shop practice	40
Algebra	70
Geometry	40
Trigonometry	30
Physics	70
Materials	35
Industrial history	35
Mechanics, strength of materials, and mechanical design	70
Total	560

The class is composed at present of 65 apprentices, most of whom are learning the machinist's trade. The sessions are held during working hours in a room in the factory fitted up with drawing tables and blackboards. No shop equipment is used. The purpose of the course is to develop a body of trained workmen competent to take positions in the factory as foremen or heads of departments. Less than one-tenth of the total time of the course is devoted to the study of shop practice. Standard text-books are used in the teaching of mathematics.

The enrollment in the school conducted by the New York Central Railroad is about 140 boys, nearly all of whom are machinists' apprentices. They are divided into three classes, and the members of each class attend the school four hours a week. About two-thirds of the time is devoted to mechanical drawing and one-third to mathematics and shop practice. The instruction in these two latter subjects is based on a series of graded mimeographed or blue print lesson sheets, containing a wide variety of shop problems, with a condensed and simplified explanation of the mathematical principles involved. In the main, the work is limited to the application of ordinary arithmetic to shop practice. No textbooks are used, but the booklets on machine shop practice published by the International Correspondence Schools are studied in connection with the course.

In addition to the required classroom work in mechanical drawing, each apprentice serves four or five months of his term in the regular drafting rooms

of the company. The classroom contains models of railway appliances and machinery, together with laboratory apparatus for teaching the laws of mechanics. No machine tools or other shop equipment are used in the classes. The course includes about 700 hours of instruction exclusive of the time spent in regular drafting room work. About 20 apprentices finished the course this year.

The Y. M. C. A. continuation school gives day instruction to 46 apprentices sent to the school by various firms in the city under an arrangement whereby the boys attend four and one-half hours each week during shop time. The employers pay the tuition fee, which amounts to $20.00 a year. The course covers four years' work of 40 weeks each, a total of 720 hours. It comprises instruction in shop mathematics, drawing, English, physics, and industrial hygiene. No shop equipment is used, although the teacher in charge believes that with a larger class a variety of machine tools for demonstration purposes would be of advantage. Fifteen boys were graduated from the course this year.

The factory apprentice school possesses many advantages over any kind of continuation or night school conducted outside of the plants where the boys are employed. A closer correlation of the work in the school and the shop and a more personal relation between teacher and pupils are possible than in schools in which the enrollment is made up of apprentices from several different establishments. On the other hand, this method of training appren-

tices is not feasible except in very large plants, as the teaching cost becomes prohibitive when the classes are small. It is not likely to be adopted by enough manufacturers to take care of more than an insignificant proportion of all the boys who enter these trades.

The results obtained, here and in other cities, through coöperative schemes, such as the Y. M. C. A. continuation school, are on the whole disappointing. Their failure to reach more than a few of the boys who need trade-extension training is due in part to the fact that they operate under a condition that is fundamentally unjust. One employer interviewed during the Survey stated the case very clearly: "I can see no good reason why I should make pecuniary sacrifices for the benefit of my competitors. Very few of my apprentices remain until the end of their term, because by the time they have completed their second year other firms who make no effort to train their quota of skilled workmen for the trade, steal them away from me. Any plan for the training of apprentices which does not apportion the burden among the different establishments in direct proportion to the number of men they have, simply penalizes those public-spirited employers who participate in it." It is open to serious doubt whether any extension of the system of public vocational education should be considered that limits its benefits to a particular type of worker. The total number of apprentices in the city constitutes only a part of the body of young workers employed in industry, most of whom need supple-

mentary instruction quite as much as the apprentices.

It is the opinion of the Survey Staff that the only practicable solution of this problem lies in the day continuation school, backed by a compulsory law which will bring every boy and girl at work under the age of 18 into a day continuation school for a certain number of hours per week. Only through a comprehensive plan that will reach large numbers of young workers can the difficulties inherent in the administration of small classes be overcome. Night school classes have never been successful in holding boys long enough to make more than a beginning in trade-extension training, and it is very doubtful whether growing boys should be expected to add two hours of study to their nine or 10 hours of unaccustomed labor in the shop. Both individual and community interests demand that this problem be taken up in such a way as to obviate the sharp cleavage between the boy's school life and his working life. From every point of view it is unwise to permit him to lose all contact with the educational agencies of the city before he reaches a relative degree of maturity.

This is of special importance in Cleveland because many thousands of the future industrial workers of this city are being educated in the private and parochial schools and not in the public ones. It is of paramount importance that they should all be brought into contact with the educational facilities provided by the public and made to realize, through contact, that teachers, libraries, shops, meeting places,

recreational facilities, and disinterested counsel are all available for the ambitious man who wishes to progress personally and vocationally.

Trade-extension Training for Machine Operators, Helpers, and Journeymen

In January, 1916, the enrollment of metal trades' journeymen, helpers, and machine operators in the technical night schools was approximately 400. The investigation conducted by the Survey obtained replies from 335 students employed during the day in these trades. Of this number, 236 were machine operators and helpers, 70 machinists and tool makers, 14 pattern makers, and 15 journeymen and helpers from other metal trades.

Approximately one-half of these men were enrolled in the machine shop course and nearly one-fourth in mechanical drawing classes. The remainder were distributed among 16 different courses, most of which bear little relation to the metal trades. Over 80 per cent of the machine operators and helpers were enrolled in the machine shop course, while the number of journeymen machinists and tool makers taking mechanical drawing was nearly twice the number taking shop work. As in the case of the apprentices, only a small proportion continue in the school more than two or three terms.

Due to the large number of young men who enter the factories each year to take up machine tool operating, the matter of trade-extension training for

machine work is of greater importance than in those industrial occupations in which the apprentice system is in more general use. The majority of these men have never had any opportunity to become familiar with shop theory, and in consequence are not only less efficient than they should be in the specialized jobs in which they are engaged, but are unable readily to adapt themselves to changes in the conditions of their work, or take up new and better employment when they have a chance. The fact that the technical high schools are unable, even with their extensive shop facilities, to meet the demand for this kind of instruction, is sufficient proof that these men realize the need for a broader knowledge of the trade than they can obtain in the shops.

Often they want specific and definite instruction relating to adjusting or setting up a particular tool. A course of two or three years, such as might be given to apprentices, does not appeal to them. Their previous educational preparation varies widely, and some are not capable of assimilating even the specialized bit of trade knowledge they want without a preliminary course in arithmetic. As the personnel of the class changes to a marked degree from term to term, the courses require frequent modifications.

More ample facilities than now exist in the technical night schools are needed if this situation is to be adequately met. The classes are taught by members of the high school teaching force, who bring to the work only the margin of energy and interest remaining at the end of the regular school day. This

system is unjust to both the teachers and the pupils. The man who sacrifices his recreation time in order to prepare himself for better work deserves the best the schools can give; nor can the teacher long continue working a two-hour night shift in addition to seven or eight hours in the day school without seriously impairing his efficiency.

Trade-extension instruction for the metal trades represents one of the most important phases of the general problem of supplementary education for adult workers. Until it becomes something more than one of the marginal activities of the technical high schools it will fail to yield its full measure of economic and social value. The operation of night schools for men and women should be based on the same broad principles that make for the successful administration of day schools for boys and girls. A related but distinct organization should be developed and maintained to meet the universal need for supplementary training of industrial workers. It should be flexible enough to accommodate itself to a wide range of educational requirements, and must command the services of a separate staff of teachers who have not already used up their best energies in other work.

SUMMARY OF TRADE CONDITIONS

1. The "foundry and machine shop products" group of industries ranks first in the city in point of number of workers, employing approximately 25,000 wage-earners.

2. About two-thirds of the workers are classified as machinists. They constitute by far the largest group of skilled workers in the city.
3. There are more native born workmen in the machinists' trade than in the four next largest trades combined.
4. The proportion of machine tool operators to all-round machinists or tool makers is approximately three to one.
5. The time required to learn machine tool operating ranges from two weeks to 15 months, depending on the machine tool and the shop organization.
6. A universal objection among employers to the apprenticeship system is the fact that many apprentices leave before the end of their term in order to take employment at higher wages as machine operators.
7. The difference between the earnings of all-round machinists and good machine operators is so small that there is little financial inducement to serve the full apprentice term.
8. In none of the skilled trades are the average wages lower than those of all-round machinists.
9. The usual working day is from nine to 10 hours, and the usual working week from 54 to 60 hours.
10. Modern shop organization has brought about marked changes in the conditions of foremanship. Today such personal qualities as initiative, resourcefulness, tact, and self-control are more necessary than technical knowledge and skill.

11. The trade is not well organized, and the union exercises very little influence in determining wage rates and conditions of labor. No union shops were found among the establishments visited.
12. Pattern making, although a small trade, offers the most interesting work and pays the best wages among the metal trades. It is usually learned through an apprenticeship.
13. Molding and core making are distinctly foreign trades, employing less than 20 per cent of native labor. They offer public school boys few opportunities for employment.
14. Blacksmithing, like molding, is recruited largely from foreign labor. The proportion of American blacksmiths is steadily decreasing. Due to improvements in manufacturing processes the old-time blacksmith has practically disappeared, except in small repair shops.
15. Boiler making is a small trade offering but few opportunities for employment. The per cent of increase in the number of boiler makers in Cleveland during the decade 1900–10 was only one-ninth that of the general population.

SUMMARY OF TRAINING RECOMMENDATIONS

1. Vocational training for the metal trades has to do with four types of people: boys still in school, apprentices, machine operators and helpers, and journeymen.

2. Only a small proportion of the boys who enter the metal trades remain in school beyond the eighth grade. Most of them are retarded one or more years when they leave school.
3. The fundamental purpose of vocational training should be to give pupils a knowledge of the mathematical and mechanical principles on which trade processes are based, through concrete applications of these principles in the solution of shop problems.
4. Neither the elementary schools nor the junior high schools at present offer vocational training of any kind.
5. The technical high schools are equipped for practical instruction in machine work, molding, pattern making, and blacksmithing, but few boys who complete the course engage in manual work for any considerable length of time. These schools are primarily training schools for future civil, electrical, and mechanical engineers.
6. The number of boys in the upper grades of the average elementary school is too small to warrant the establishment of vocational courses.
7. It is recommended that a general industrial course be given in the junior high schools covering shop mathematics, mechanical drawing, and the principles of industrial physics, closely related throughout the course to the shop work. The equipment should include a small machine shop, together with several types of machines to be used for practice in assembling operations.

The study of economic and working conditions in industrial and commercial occupations should form a part of the course.

8. The period of compulsory school attendance should be increased one year, so that the age at leaving school may coincide with the minimum entering age in the trades. There is little opportunity for boys under 16 to secure employment that offers any prospect of advancement.
9. A two-year vocational school admitting boys should be established in order to provide an opportunity for boys between 14 and 16 to obtain practical training in the trades before they leave school.
10. Trade-extension training for apprentices is given in night classes in the technical night schools. The present enrollment of metal trades' apprentices is between 125 and 150. Approximately two-thirds of them are learning the machinist's trade and about one-third pattern making. Nearly all are either taking shop courses in their respective trades or mechanical drawing. The average length of time they attend amounts to less than one month in an ordinary school.
11. There are two factory schools in the city, one in the Warner and Swasey Company factory and the other in the New York Central Railroad shops. The instruction differs from that given in the night schools principally in the fact that they use no shop equipment in the classrooms.

The Y. M. C. A. continuation school, which gives day instruction to a class of 46 apprentices sent to the school by various firms in the city, follows the same plan. In all of these schools the instruction is limited, for the most part, to mathematics, mechanical drawing, and the theory of shop practice.

12. Factory schools are practicable only in large plants. Good results have not been obtained through the voluntary coöperation of employers with the private or public schools.
13. It is the opinion of the Survey Staff that the need of vocational training for all young workers can be met effectively and justly only through compulsory day continuation classes.
14. Between 350 and 400 metal trades' journeymen, machine operators, and helpers are now enrolled in the technical night schools. Of these, about 73 per cent are machine operators and helpers, and 27 per cent journeymen. Approximately one-half were enrolled in the machine shop course and one-fourth in mechanical drawing classes.
15. In order to meet the general demand for supplementary instruction for the trades, the industrial night schools, which are now a mere side-line of the technical high schools, need a wider curriculum, a separate organization, and a teaching force that can give its best energies to the work.

PART II

AUTOMOBILE MANUFACTURING

The rise and growth of the automobile manufacturing industry have been phenomenal. Twenty years ago it was practically non-existent; today it takes high place among the leading industries of the country. In 1899 only 2,241 wage-earners were engaged in the manufacture of automobiles. Ten years later the industry employed 75,721 workers, or over 33 times as many. The value of the product rose during the same period from $4,748,000 to $249,202,000, an increase of more than 50 fold.

Many factors contributed to this rapid development. A new industry, making an entirely new product, it was unhampered by manufacturing traditions. The unprecedented demand, together with the constant introduction of improvements in the various types of machines, taxed the resourcefulness and ingenuity of the manufacturers to the utmost. As they scrapped their last year models, so they scrapped many a cherished shop tradition, and the influence of the industry on general manufacturing methods has been only a degree less revolutionary than the changes it has brought about in street and road transportation.

From the first, Cleveland's position in the industry has been notable. In 1909 this city was surpassed by only one other in the country—Detroit—in the production of motor cars, bodies, and parts. With respect to the number of wage-earners employed—estimated at 15,000 men in 1915—automobile manufacturing ranks second among the industries of the city, and third in value of product.

High Standards and Low Skill

No machine makes greater or more exacting demands on manufacturing processes than the automobile. No other machine has to meet such severe tests under such widely varying conditions. Built to run at any speed, on every sort of road, with every kind of driver, it is a marvel of mechanical efficiency.

In its manufacture a high standard of mechanical perfection is attained with relatively low-skilled labor. Due partly to the fact that the exigencies of the market compelled the adoption of more rapid methods of production, and partly to the shortage of skilled labor, this industry has specialized its factory processes to a degree found in few other lines of manufacturing. Automobile manufacturing and the reform in methods of shop organization known as scientific management started about the same time. The adoption of the new methods was comparatively easy in an industry unfettered by custom and tradition, and automobile manufacturers were quick to see and grasp their advantages for large scale pro-

TABLE 10.—LIST OF OPERATIVES IN A TYPICAL AUTOMOBILE FACTORY

Wage workers	Per cent
Productive—54 per cent	
Drill press operators	9.6
Lathe hands	7.4
Milling machine operators	5.4
Hand screw machine operators	4.0
Bench hands	3.6
Wood machine operators	3.1
Automatic screw machine operators	2.5
Bench molders	2.3
Machine molders	2.3
External grinders	1.8
Sheet metal machine operators	1.6
Core makers	1.6
Blacksmiths	1.1
Internal grinders	.9
Polishers	.9
Gisholt machine operators	.9
Tool makers	.8
Cleaners	.8
Turret screw machine operators	.7
Gear cutters	.5
Tinners	.5
Disc grinders	.3
Heat treaters	.3
Floor molders	.3
Electric welders	.1
Semi-automatic machine operators	.1
Acetylene welders	.1
Furnace tenders	.1
Gear shaper operators	.1
Tumblers	.1
Sand blasters	.1
Flask makers	.1
Assembling—17 per cent	
Body assemblers	3.1
Motor assemblers	2.6
Chassis assemblers	2.6
Transmission assemblers	2.2
Steering gear assemblers	1.7
Fender fitters	.9
Axle assemblers	.8
Clutch assemblers	.8
Final finishers	.8
Body fitters	.7
Electricians	.5
Wheelmen	.3
Finishing—12 per cent	
Back hangers	1.6
Cushion makers	1.6
Sewers and pasters (women)	1.3
Gear painters	.9
Top makers	.9
Varnish rubbers	.9
Sanders	.8
Rough stuff rubbers	.7
Back makers	.7
Enamelers	.5
Sprayers	.5
Color varnishers	.5
Finish varnishers	.5
Stripers	.3
Cutters	.1
Hardwood finishers	.1
Rough stuff men	.1
Inspection—6 per cent	
Road testers	2.6
Parts inspectors	1.8
Motor tester	1.6
Miscellaneous—11 per cent	
Laborers	10.0
Millwrights	.9
Carpenters	.1

duction. As a result the skilled craftsman forms but an insignificant part of the working force, which is made up chiefly of the sort of labor that can be taught to run a single machine or perform a single assembling process within a few days, weeks, or at the most, months. From 50 to 75 per cent of these men are immigrants, and a considerable proportion have little more than a smattering of the English language.

An idea of the lengths to which subdivision of labor has been carried in this industry may be obtained from the list of occupations in a typical factory presented in Table 10.

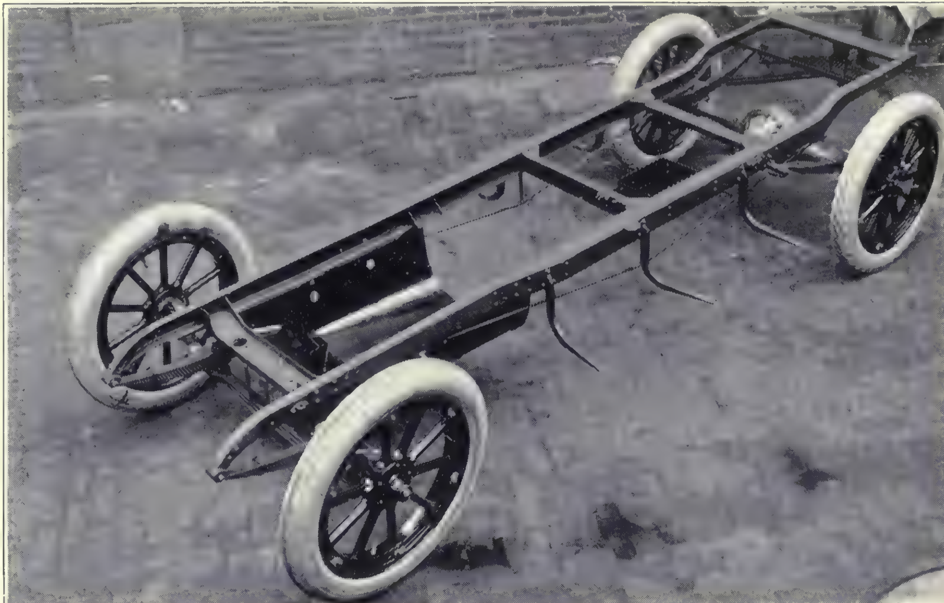
Productive Occupations

The list comprises 67 occupations in all. If classified according to the nature of the work, they fall into four main divisions or departments. The largest, which includes all the productive or manufacturing operations and gives employment to 54 per cent of the total working force, is made up chiefly of machine tool occupations similar to those described in Part I of this report. In this industry, however, automatic and semi-automatic machines are more generally used, and the subdivision of labor and simplification of machine processes have gone farther. The technical knowledge and skill formerly demanded of the workers have been transferred to the engineering and designing departments, where practically all the thinking, planning, and experimenting are done, and as a result the head work in the shop

is limited to that involved in carrying out simple instructions. The fact that production is on a large scale, requiring thousands of pieces of the same shape and size, still further simplifies the operator's task. This system has enabled the manufacturers to produce one of the most intricate machines known to modern manufacturing with a working force composed in the main of semi-skilled labor. In the productive group are found also a few old-line trades, such as molding and core making. The number of skilled men employed even in these trades is very small, as such work, like all the rest, is highly specialized.

Assembling Occupations

Next in numerical importance come the various types of assemblers. Here again specialization is carried to the n^{th} degree. There are motor assemblers, steering gear assemblers, body assemblers, chassis assemblers, transmission assemblers, clutch assemblers, and so on, each separate class engaged in putting together a single mechanical unit or part. Some of this work requires considerable experience and represents a comparatively high degree of skill. Transmission assembling, and to a lesser degree, motor assembling, for example, demand an extremely fine sense of mechanical adjustment. From these few relatively skilled operations, the work rapidly grades off to occupations that can be learned in a day or two of the type described by an assembler in an automobile factory who, when asked what



Automobile chassis, with axles, and differential installed

kind of work he did, replied that he "assembled nut No. 5."

Although the various assembling operations have certain features in common, each has its own special characteristics. Some have to do solely with fitting a part in a designated place on the chassis or body; others include not only accurate fitting, but nice adjustment, while the final assembling processes call for considerable care and manual dexterity. In the first group are found the simpler operations, which may be likened to fitting together the sides of a box after the edges have been dovetailed. The work is all laid out for the operative, and he simply fastens the part in its proper place. The work of the fender fitters, who attach the fenders, or mud guards, to the body, and the axle assemblers, who bed or fit the axles to the chassis, are examples of this type of assembling. In the second group would be placed assemblers of such parts as the steering column, transmission, clutch, and engine. Here each worker has to deal with a complete mechanical unit, and some knowledge of the working parts and their functions is necessary. Each piece has to be fitted accurately and made to operate with the least possible friction. It must not only be properly placed, but carefully adjusted so as to insure perfect alignment and noiseless operation. The work of fitting the body, hanging doors, and performing other final finishing operations is done by another group. The men who do this work must be careful as well as skilful, as a single careless stroke is likely to mar or

deface a finished part of comparatively high value. Nearly all assembling is primarily hand work. It exacts little in the way of technical knowledge, but demands close attention and constant activity.

Finishing Occupations

Several of the finishing occupations, such as painting and cushion-back making, employ men from the skilled trades, although this work also is specialized to an unusual degree. The painting, for example, is subdivided into seven distinct occupations, of which but four—stripers, finish varnishers, hardwood finishers, and enamelers—rise above the grade of semi-skilled labor.

Inspecting and Testing Occupations

Nearly all local establishments purchase parts of their cars from other factories which specialize on a single product. This has given rise to a large body of related manufacture engaged in making chassis frames, wheels, castings, engine parts, drop forgings, and the like. One company in Cleveland buys all the parts of its machine from outside manufacturers and performs only the assembling and finishing operations in its own factory. Every piece is tested as it is received, and the plant includes a small machine shop where minor defects are corrected before the parts are turned over to the assemblers. A relatively large number of inspectors or testers are em-

ployed in an establishment of this kind. As a rule, they have to understand the use of highly accurate measuring instruments, be able to read blue-prints, and possess a general knowledge of machine shop practice.

The plant which manufactures all its own product requires a smaller force of testers and inspectors, who submit to careful tests such parts as the axles, motor, chassis, etc., before they are placed in the machine. The running parts, in particular, are tried out and adjusted. The engine is run for some time both under auxiliary power and its own power at varying rates of speed. In this way defects in construction or operation are noted and corrected before the engine is placed in the car. The transmission, also, is connected with a power-giving device and tested in similar fashion.

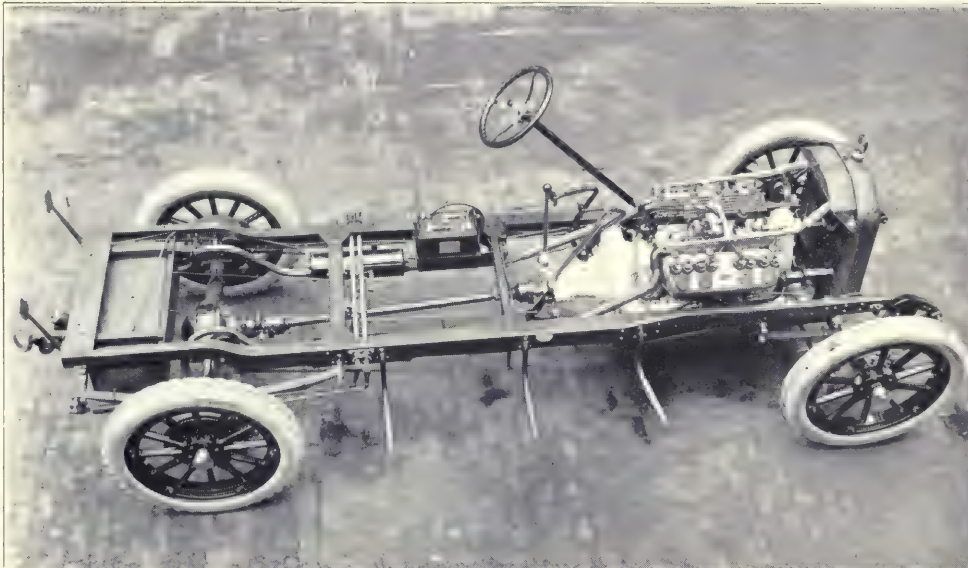
Wages and Regularity of Employment

It is somewhat difficult to compare wages in automobile manufacturing with those paid in other industries, on account of the difference in the classification of occupations and arrangement of work. Operations that in the ordinary manufacturing plant are performed by one man are here subdivided into four or five, each bearing a different name and performed by a different individual. This subdivision of processes tends always to the employment of a low-skilled working force. The skilled worker is necessarily at a disadvantage. An all-round ma-

chinist in an automobile repair shop, where the varying character of the work demands a thorough knowledge of the whole trade, can usually earn more than in a factory where he works on a single operation day after day. The work in the factory demands only a small proportion of his general knowledge and skill. He can market only part of his complete stock in trade, and the price he gets is correspondingly less.

The wages in automobile factories are not, however, any lower for the same grade of labor than in other industries. Moreover, a low-paid occupation is not necessarily under-paid. Chassis assembling, for example, is low-paid work, that is, the average wage of about 25 cents an hour is small compared with that of a tool maker, a color varnisher, or a transmission assembler. But the chassis assembler compares his wages, not with those earned by tool makers, but with what he could get as a common laborer, which he would almost certainly be were he not a chassis assembler. The same rule holds with respect to a large number of the men employed in this industry. They are not artisans reduced to a lower economic level by specialization, but chiefly semi-skilled workers to whom specialization has afforded the means of reaching a higher industrial and economic status.

Table 11 shows the average rate per hour for each occupation. The rates given are only approximately accurate, as much of the work is paid by the piece, so that earnings vary according to the ability of the worker. Wages have increased somewhat since these data were collected.



Automobile ready for the body and finishing operations

TABLE 11.—AVERAGE HOURLY RATES OF WAGES IN AUTOMOBILE FACTORY OCCUPATIONS, CLEVELAND, 1915

Wage workers	Hourly rate
Under 25 cents—23 per cent of workers	
Sewers and pasters (women)	18.3
Cleaners	20.0
Laborers	20.2
Tumblers	21.0
Bench hands	21.2
Acetylene welders	22.0
Electric welders	22.0
Sanders	23.0
Gear cutters	23.4
Sand blasters	23.6
Drill press operators	24.2
Heat treaters	24.9
25 to 30 cents—59 per cent of workers	
Chassis assemblers	25.0
Fender fitters	25.0
Flask makers	25.0
Rough stuff men	25.1
Wheelmen	25.3
Body assemblers	25.4
Semi-automatic machine operators	25.5
Disc grinders	25.6
Polishers	26.1
Gear painters	26.5
Milling machine operators	26.6
Varnish rubbers	27.2
Enamelers	27.3
Blacksmiths	27.4
Steering gear assemblers	27.6
Motor testers	27.7
Millwrights	27.8
Body fitters	27.9
Rough stuff rubbers	28.0
Final finishers	28.1
Motor assemblers	28.1
Transmission assemblers	28.2
Clutch assemblers	28.2
Axle assemblers	28.6
Hand screw machine operators	29.0
Gisholt machine operators	29.2
Wood machine operators	29.2
External grinders	29.2
Internal grinders	29.2
Lathe hands	29.5
Parts inspectors	29.6
Automatic screw machine operators	29.6
Sheet metal machine operators	29.8
30 to 35 cents—10 per cent of workers	
Floor molders	30.0
Gear shaper operators	30.0
Carpenters	30.0
Furnace tenders	30.6
Electricians	30.8
Turret screw machine operators	30.9
Core makers	31.5
Sprayers	31.6
Cushion makers	31.6
Tinners	31.8
Hardwood finishers	32.0
Back makers	32.3
Road testers	32.6
Color varnishers	34.1
Top makers	34.8
35 cents and over—8 per cent of workers	
Back hangers	35.2
Bench molders	35.6
Machine molders	35.6
Tool makers	36.3
Cutters	37.7
Finish varnishers	40.0
Stripers	41.1

The lowest group, earning less than 25 cents an hour, comprises common labor and such work as cleaning castings, the simpler welding operations, sand blasting, gear cutting, and drill press operating. In the next group, earning from 25 to 30 cents an hour, are found all the machine occupations except gear shaping, turret screw machine operating, and tool making, with every type of assembling and all the testing and inspection work except road testing. The two remaining groups, 30 to 35 cents an hour and 35 and over, contain what may be called the aristocracy of the labor force. Here there are a few of the old-line trades, such as molding and painting.

On the whole, wages compare favorably with those paid in other metal industries. Weekly earnings average above those in the foundry and machine shop products group, where a somewhat higher grade of labor is employed. A comparison on this basis between automobile manufacturing and all other industries in the city reporting over 3,000 male employees to the State Industrial Commission in 1914 is shown graphically in Diagram 2. Under "Automobiles" are included a large number of plants engaged in the manufacture of automobile parts, such as bodies, engines, springs, etc., in which wages are usually higher than in the establishments which assemble the cars.

In the proportion earning $25 a week and over, automobile manufacturing easily leads the metal industries, although it falls far below printing and publishing, where effective labor organization has

been a decisive factor in fixing rates of wages. In the foundry and machine shop products group, which is most nearly comparable with the automobile industry on the basis of similarity of work and products

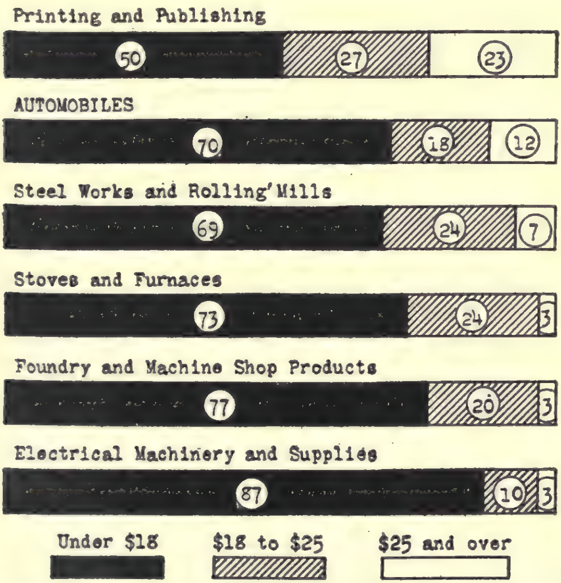


Diagram 2.—Per cent of men over 18 years of age earning each class of weekly wages in six of the principal industries in Cleveland

there is approximately one-fourth as great a proportion of men earning $25 a week and over as in automobile manufacturing. The relatively high weekly earnings are due in part to the general use of the piece work system of payment, especially in

plants engaged in the manufacture of automobile parts.

It must be borne in mind, however, that this industry is seasonal, the number employed fluctuating to a marked degree between the busy and slack sea-

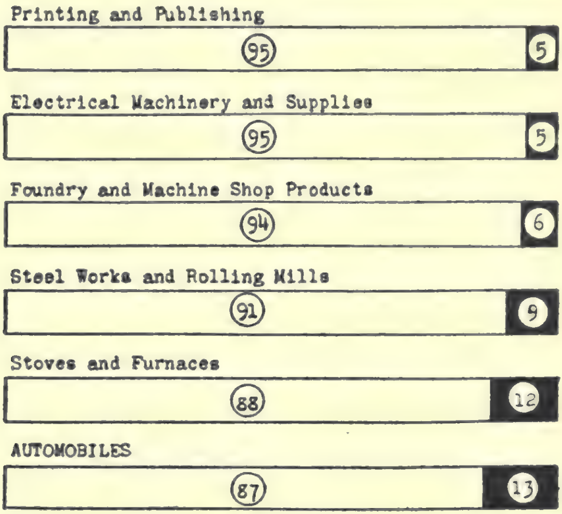


Diagram 3.—Sections in outline represent average percentage of men employed and sections in black average percentage of men unemployed during the year in each of six large industries in Cleveland

sons. In 1914 almost one-fourth of the total working force was laid off at some time during the year. The extent of fluctuation as compared with other industries is seen in Diagram 3. The rush season comes in the months of October, November, and December,

and the dull season in June, July, August, and September.

Chances of Promotion

Promotion may mean either increased pay for manual work or a change from manual to directive or

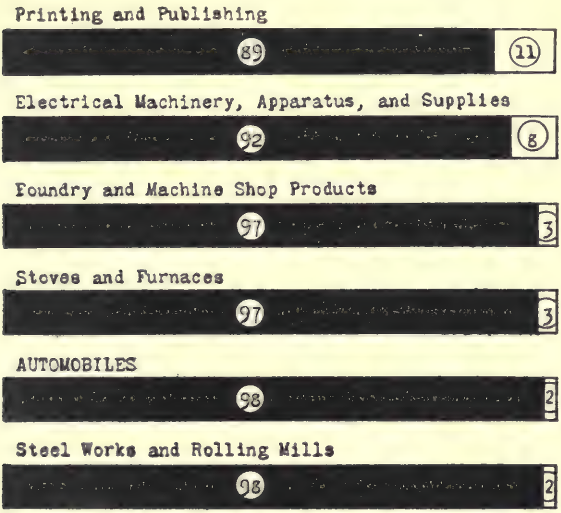


Diagram 4.—Proportion of supervisory and executive positions to number of wage-earners in six of the principal manufacturing industries. Black portion indicates per cent of wage-earners; white portion per cent in supervisory and executive positions

supervisory work, such as that of overseers, foremen, and managers. The diagram on page 91 and the table on page 89, showing the proportion who earn the higher rates of pay, afford a clear idea of the

chances of promotion to good wages. The opportunities for getting out of wage-earning into the salaried positions depend primarily on the number of such positions there are in comparison with the number of wage-earners the industry employs. Such a comparison is shown in Diagram 4. It does not include women wage-earners, as very few women in these industries ever rise to executive positions.

It may be set down as a general rule that the larger the manufacturing unit, the smaller the chance of advancement to supervisory and managerial work. This is strikingly illustrated by the conditions prevailing in the automobile industry. The establishments are few in number and large in size, with the result that none of the industries compared in the diagram employs fewer salaried men in proportion to the number of wage-earners. Among the six industries, printing and publishing, in which the establishments are small but numerous, stands at the head of the list with respect to the chance it offers the worker to pass from the wage-earning class to salaried employment.

Hours of Labor, Union Organization, and Health Conditions

The working day is usually 10 hours and the working week either 54 or 60 hours. One factory recently changed to the eight-hour day. In several plants it is the custom to pay on a nine-hour basis with time and a half, or an increase of 50 per cent, for the tenth

hour. During the rush season a good deal of overtime work is necessary.

All the factories are run on the open shop basis. The labor unions are not at present an important factor in fixing hours of labor, rates of wages, or other working conditions. In many of the occupations no union organization exists. The simplified character of the work, and the fact that a large proportion of the employees are foreign-born immigrants of different nationalities augment the difficulties of collective action.

Health conditions and accident risks correspond to those already described in Part I. Most of the factories are of modern construction, with ample lighting and ventilating facilities.

Time Required to Learn

Perhaps the most remarkable achievement of specialization is the way it has shortened the learning period in all lines of work, including even the so-called skilled occupations. Many of the workers in automobile factories are recently transplanted peasants from the fields of Bohemia and Poland. They come with no previous experience in factory work of any kind. This type of labor is taught within a few weeks or months to do efficient work in assembling and in many kinds of machine operating on which not many years ago only skilled artisans were employed. The method is based on comprehensively planned shop organization and minute subdivision

of processes. It is subversive of every tradition of craftsmanship, but it seems to work.

Nearly half of the working force are employed in occupations which can be learned in one month or less. About nine-tenths are engaged in work requiring not over six months to learn. The estimates shown in Table 12 are based on data furnished by several factory superintendents. They represent the usual amount of experience required to earn average wages, which is another way of saying that the estimate is based on average ability rather than on expert ability. Certain conditions of the work must be considered in judging an estimate of this kind. For example, in a jobbing foundry a molder works on molds of many sizes and shapes, while in an automobile factory the castings do not vary in form during an entire season. Under a good foreman a green hand can learn this kind of molding in a month or two.

The Problem of Training

In general, the problem of vocational training for the productive occupations of automobile manufacturing has been covered in the section of Part I dealing with training for the machine trades. It cannot be denied, however, that the highly specialized shop organization in general use in automobile factories obviates, to a considerable degree, the need for technical knowledge on the part of the workers. The new methods of large scale production must

TABLE 12.—ESTIMATED TIME REQUIRED TO LEARN AUTOMOBILE MANUFACTURING OCCUPATIONS

One month or under—44 per cent
- Drill press operators
- Heat treaters or hardeners
- Bench hands
- Polishers
- Disc grinders
- Cleaners
- Flask makers
- Furnace tenders
- Machine molders
- Motor testers
- Fender fitters
- Clutch assemblers
- Axle assemblers
- Body fitters
- Steering gear assemblers
- Final finishers
- Wheel men
- Transmission assemblers
- Chassis assemblers
- Sewers and pasters (women)
- Rough stuff men
- Sanders
- Hardwood finishers
- Sprayers
- Acetylene welders
- Electric welders
- Sand blasters
- Tumblers
- Laborers

Two months—15 per cent
- Semi-automatic machine operators
- Milling machine operators
- Body assemblers
- Sheet metal machine operators
- Gear painters
- Enamelers
- Back makers
- Back hangers
- Cushion makers

Three months—12 per cent
- External grinders
- Internal grinders
- Hand screw machine operators
- Floor molders
- Bench molders
- Core makers
- Top makers

Four months—2 per cent
- Turret screw machine operators
- Varnish rubbers
- Rough stuff rubbers

Six months—14 per cent
- Gear shaper operators
- Lathe hands
- Automatic screw machine operators
- Gisholt machine operators
- Gear cutters
- Wood machine operators

Six months to one year—2 per cent
- Parts inspectors

One year—4 per cent
- Stripers
- Finish varnishers
- Color varnishers
- Road testers

Two to three years—4 per cent
- Tinners (specialists—2 to 3 months)
- Electricians
- Motor assemblers (specialists—1 month)
- Cutters

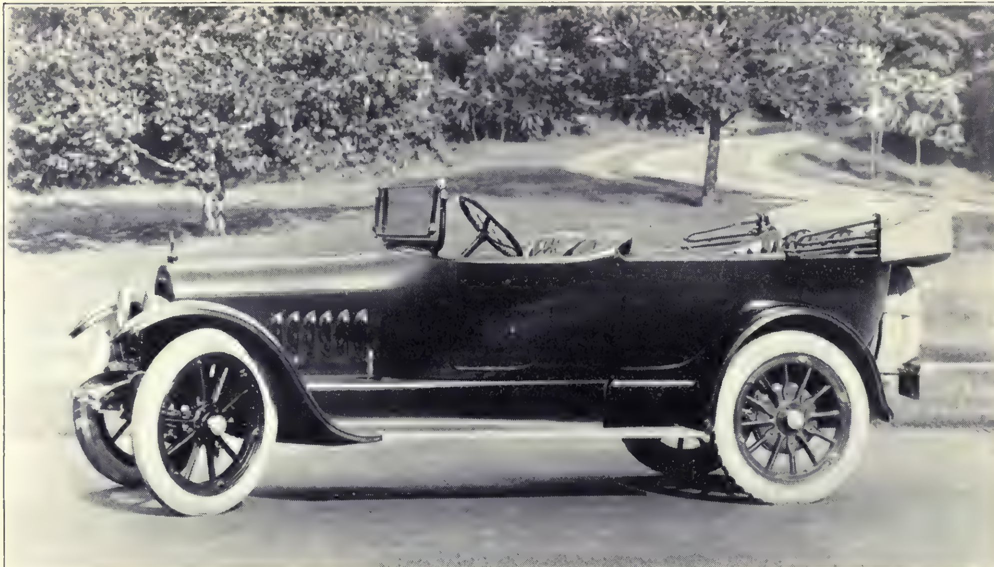
Three to four years—2 per cent
- Blacksmiths (specialists—2 to 3 months)
- Millwrights
- Carpenters

Four years—1 per cent
- Tool makers

ultimately force a radical revision of all our preconceived notions as to the importance and value of training for many types of industrial work.

In many of the establishments the all-round workman has almost entirely disappeared. To such an extent is this true that not a single factory included "machinists" in the list of occupations reported to the Survey. The proportion of workers who can make any use of trade theory is small. The head work is done outside the shop. The plants are large enough to afford first-class engineering departments, manned by mechanical experts who plan the work to the last detail, so that when an order reaches the shop there is little to do except follow detailed instruction. As a rule, changes in form, size, or composition of the parts occur only once each year, and it often happens that a man works for months at a single machine on thousands of exactly similar parts. Those who have observed the effect of constant repetition in teaching will readily understand how these peculiar conditions favor rapid mastery of the restricted tasks set for the workers, and how it is possible for the factories to break in untrained immigrants to do efficient work on the simpler machine tools in the space of a few weeks.

Many workmen would be glad to avail themselves of an opportunity to learn other machine tools than the ones on which they are employed, in order to secure more remunerative work, or to prepare themselves for employment in other industries where a full knowledge of the trade is required. Evening in-



The completed car

struction of the kind suggested in Part I would enable them to overcome many of the disadvantages of specialized machine work.

For the simpler forms of assembling no training is possible that cannot be obtained more quickly and economically in the shop. The truth is that in much of this work there is little to train for. Unless the worker is feeble-minded, the series of movements he constantly repeats in the same order and manner becomes automatic within a few days.

If the evening schools were provided with equipment for teaching motor and transmission assembling, they could materially help workers engaged in these occupations, and those who wish to qualify for them. Such an equipment would cost little, and as no material is consumed during instruction, the expense except for the teacher's salary would be slight.

A few men in the testing and inspection departments could profit by short unit courses on testing and measuring instruments. On the job they learn only the restricted application of such instruments to the particular work on which they are engaged. A man can soon learn to make micrometer tests of machine parts of a uniform size, but if he knows nothing of the principles involved in the construction and use of the instrument, he will be at a loss if called on to test parts of varying sizes and shapes.

Vocational training can perform its greatest service to the wage-earner in this industry by affording him the opportunity to "add another string to his bow." The conditions of employment are unstable,

due to the seasonal character of the industry, and in consequence there is a marked shift in the working force each year. Thousands of men are laid off from one to four months during the dull season. When work on the cars for the following year begins, the employee who returns to the factory may find that his old job has already been filled, although there may be jobs open in other departments or on another machine. If a screw machine hand also knows how to run a milling machine and a turret lathe he has three times as many chances of securing a job as if he knew but the one machine. In the same way the man who knows several kinds of assembling is much better off than he who knows only one kind. The factory affords few opportunities for learning more than one thing, and the evening schools can render automobile workers a real service by affording them a chance to broaden their experience in machine and assembling processes. The technical high schools already have a full equipment for machine tool work, and the material for the principal types of assembling could be secured at relatively small cost.

Summary

1. Automobile manufacturing ranks second as to number of wage-earners among the industries of Cleveland and third as to value of products.
2. The industry is characterized by extreme specialization in manufacturing processes.

3. The working force is composed for the most part of semi-skilled labor of which 50 to 75 per cent is foreign born.
4. The productive occupations include 54 per cent of the working force, assembling occupations 17 per cent, finishing occupations, 12 per cent, inspection occupations six per cent, and common labor 10 per cent.
5. Wages compare favorably with those paid in other metal industries, but the seasonal character of the work seriously affects steadiness of employment.
6. The usual working day is 9 or 10 hours, and the usual working week 54 or 60 hours.
7. The chance of promotion to high wages is relatively good. The chances for promotion to supervisory and executive positions are few, due to the size of the establishments and the centralized factory organization.
8. The unions do not at present constitute an important factor in determining conditions of labor.
9. Nearly one-half of the workers are employed in work that can be learned in one month or under, and three-fifths in work requiring two months or less to learn.
10. The problem of vocational training for the productive occupations is similar to that for other machinery manufacturing industries, except that the extreme specialization found in automobile manufacturing renders unnecessary for

most of the workers an all-round acquaintance with the trade. For those who desire to broaden their experience or to study related theory, night classes similar to those described in Part I are recommended.

11. Instruction in motor and transmission assembling might well be given in evening classes. The other assembling operations are simple and may be learned in the factory in a few days.
12. Evening classes for teaching the theory and use of measuring instruments would meet a real need of workers in the inspection departments.
13. Vocational training for the wage-earners of this industry can perform its greatest service by affording an opportunity to learn a variety of operations, so that in seeking employment the worker may not be limited in knowledge or experience to a single machine or process.

PART III

STEEL WORKS, ROLLING MILLS, AND RELATED INDUSTRIES

The group of related industries composed of steel works, rolling mills, blast furnaces, wire and nail mills, and bolt, nut, and rivet factories ranks first in the city in point of total value of manufactured products, and third as to number of workers employed—between 12,000 and 15,000 at the present time. The products cover a wide range, from pig iron and steel billets to such finished articles as fence wire and bolts, and involve a great variety of manufacturing processes, from converting iron into steel at the rate of hundreds of tons an hour, to making nails with machines that turn out 500 nails a minute. The establishments visited during the Survey included blast furnaces, Bessemer and open hearth steel converting plants, blooming mills, rod mills, wire mills, nail mills, and bolt, nut, and rivet factories.

A detailed description of the numerous manufacturing processes or a separate consideration of each of the industrial occupations in this group is beyond the scope and purpose of the present study. A mere list of the processes would cover several pages.

Table 13, which lists the skilled and semi-skilled occupations reported by the establishments visited, includes only those found in the operating departments. In addition, the power, repair, and maintenance departments employ a large force of men, made up chiefly of skilled and semi-skilled workers in the mechanical trades described in Part I.

Small Number of Skilled Workers

A common characteristic of all these industries is the low proportion of skilled men in the working force. With the exception of a small number of occupations employing relatively few men in each plant, most of the operations are simple and require little training beyond a short experience on the job.

TABLE 13.—WORKERS IN SKILLED AND SEMI-SKILLED OCCUPATIONS IN VARIOUS IRON AND STEEL INDUSTRIES

Blast furnaces
- Blowers
- Blowing engineers
- Top fillers
- Ore bridge operators
- Keepers
- Skip operators
- Larry men
- Stove tenders
- Water tenders
- Blowing engineers' assistants
- Pig machine bosses
- Weigh bosses
- Cagers
- Keeper's helpers
- Pig machine men

Bessemer steel converters
- Blowers
- Vesselmen
- Stopper setters
- Steel pourers
- Vessel men's helpers
- Ladle liners
- Regulators, first
- Regulators, second
- Stopper makers
- Bottom makers
- Ladle liners' helpers
- Bottom makers' helpers
- Mold cappers

Open hearth steel converters
- Melters

Melters' helpers, first
Steel pourers
Charging machine operators
Nozzle setters
Ladle cranemen
Melters' helpers, second
Ingot strippers
Melters' helpers, third
Nozzle setters' helpers
Bottom cast men
Stock cranemen

Blooming mills

Rollers
Heaters
Manipulators
Shearmen
Cranemen
Bottom makers
Heaters' helpers
Shearmen's helpers
Bottom makers' helpers

Rod mills

Rollers
Finishers
Heaters
Roughers
Bulldoggers
Catchers
Furnace men
Shearmen
Heater's helpers
Reel men
Hookers
Snappers
Take-off men
Weighmen
Cranemen
Inspectors
Rackmen

Wire mills

Finewire drawers
Coarsewire drawers
Tinners and galvanizers
Adjusters
Fence machine operators
Cleaners
Gaugers
Fence machine operators' helpers
Reel makers
Wire handlers
Reel men
Barbed wire machine operators
Inspectors

Nail mills

Nail machine operators
Nail inspectors
Set up men
Nail operators' helpers

Bolt, nut, and rivet factories

Hot headers
Hot nut pressers (hot forged)
Hand rod headers
Cold headers
Cold nut pressers (automatic)
Turners
Inspectors
Continuous headers
Cold nut pressers (hand)
Pointers and threaders (automatic)
Pointers and threaders (large work)
Nut tappers
Drillers and tappers
Trimmers
Semi-finishers (case hardening)
Reamers

The occupations may be roughly divided into four classes. First come such positions as blowers in blast furnaces, melters in open hearth steel plants, and rollers in rod mills, all of which demand a comparatively long period of practical training and experience. The duties of a blast furnace blower are mainly supervisory. He must have a thorough knowledge of the practical side of the iron-making process. He determines what materials shall be charged in the furnace, the temperature and pressure of the air blast used in melting the ore, the time and manner of casting the molten iron, and in addition has general charge of all the labor about the furnace. The roller in a rod mill holds a somewhat similar position. He has thoroughly to understand working steel, which means mill operation rather than metallurgy. He must be an expert in such factors of production as temperature, speed, and maximum resistance of metal and men, and must know exactly what to do in case of emergencies and accidents. The work of the melter in an open hearth steel plant is of the same general character. He has charge of all the labor about the converting furnace and must possess a comprehensive practical knowledge of the open hearth process.

The second type of occupation, in which the employee does part of the work while at the same time directing a crew of helpers, is represented by such jobs as those of the vesselmen, blowers, ladle liners, and bottom makers in Bessemer steel converting plants, keepers in blast furnaces, heaters in blooming

mills and rod mills, first melters' helpers in open hearth steel plants, and steel pourers. All these positions call for care and good judgment. On account of the large scale on which the material is handled a mistake usually means a heavy financial loss to the establishment and may also cause serious injury to the employee or to his fellow-workmen. The principal requirements are a cool head and ability to think and act quickly in emergencies. The work itself can be learned only through experience and practice.

Next come such operating jobs as those of roughers, bulldoggers, catchers, and finishers in rod mills, and second and third melters' helpers in open hearth plants. They demand strength, agility, endurance, or dexterity, rather than technical knowledge. Roughers, bulldoggers, catchers, and finishers form what is known as the roll crew in rod mills. The roughers and bulldoggers pass a billet of red-hot steel about six feet long back and forth through a roll-stand resembling a magnified clothes-wringer. A few passes reduce the piece to the point where it bends easily, when it enters a semi-circular guide trough which leads it to the next roll-stand. As the end emerges from the rolls a catcher seizes it with a pair of tongs and swings it quickly around in a loop to another set of rolls. This operation is repeated at successive roll-stands until the rod is reduced to the size desired. The finisher is in charge of the last or finishing pass.

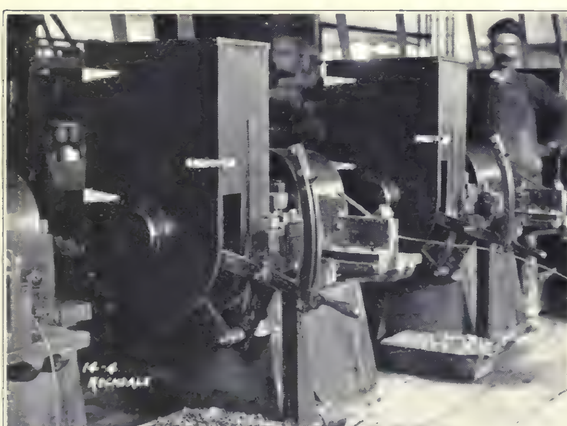
This work is of the most strenuous kind and re-

quires two gangs of men who relieve each other at intervals of 20 or 30 minutes. Agility and quickness are the prime essentials, as from three to five rods, running at a speed of over 30 miles an hour, are in the rolls at the same time. A delay at any point means an interruption of the whole process and possibly a dangerous "cobble," or tangle of the red-hot rods, before the mill can be stopped.

Second and third melters' helpers in open hearth plants are, during part of the converting process, exposed to great heat, and work under the most exhausting conditions. Endurance and strength are the first requisites for this work.

The remainder of the working force above the level of common labor is made up chiefly of machine operators and machine tenders of various kinds. Most of the labor employed in wire mills, nail mills, and bolt and nut factories belongs to this class. Such work may be subdivided into continuous and intermittent machine operating. Continuous machine operating is represented by such occupations as bolt heading, nut pressing, and pointing and threading in bolt and nut factories; intermittent machine operating by wire drawing, annealing, and barbed wire, field fence, and nail machine tending in wire and nail mills. In all these occupations the worker's principal task is to feed the machine. There is, however, this difference: in continuous machine operating the pieces of stock are small, such as nuts, or short lengths of iron rods for bolts, while in intermittent machine operating the stock is fed in larger

A row of barbed-wire machines, inclosed for safety



Fence staple machines

units, usually lengths of wire wound on reels, requiring some time to run through the machine. Continuous machine operating involves light, constant, and monotonous work, and intermittent machine operating heavy work, with frequent periods of comparative inaction.

Many different machines are used in making bolts and nuts, but they are very much alike in that all require continuous repetition of a series of simple movements on the part of the worker. The stock may consist of small pieces of iron or steel, one of which the operator places in the machine at each revolution, or, as is the case in making bolts or nuts by the hot process, it may be a six-foot iron bar heated red-hot for about half its length, which the operator holds in position and turns as successive pieces are cut off and shaped by the machine.

Wire drawing offers a good example of intermittent machine operating. In principle it consists of drawing the wire through a die provided with holes of a smaller diameter than the wire, thereby reducing it in size. Each time it is drawn the wire becomes longer and thinner. The essential parts of the machine are the die and two reels, the wire winding off one reel onto the other and passing through the die in transit. The operator's duties consist of starting the wire through the die, changing the reels when all the wire has run through, replenishing the stock, which comes in the form of spools of wire ranging from 150 to 300 pounds in weight, and watching for defects in operation and product. In barbed wire

machine and nail machine operating, the machines are automatic and the operator's principal duty is to see that they are kept supplied with wire. The work is heavy, dirty, and hard, but part of the time the operator has little to do but watch his machine.

Below the machine operators there are many kinds of jobs which differ from common labor only in that they require some preliminary practice, varying from a week to a month.

Proportion of Foreign Labor

A well-known manufacturer once said, "There is nothing American about the manufacture of iron and steel except the capital and the organization." No branch of manufacturing in the city employs a higher proportion of foreign labor. In 1910, according to the federal census, 91 per cent of the common labor employed in blast furnaces and rolling mills, and 71 per cent of the semi-skilled labor was foreign born. The results of investigations conducted during the Survey indicate that less than 20 per cent of the total operating force is of native birth. In one of the mills visited only two Americans were found in the operating departments among a total of nearly 600 employees. In other establishments where exact data had not been compiled the estimates of superintendents as to the proportion of foreign born employees ranged from 70 to 90 per cent.

The fact that many of these men do not speak or understand English does not seem to be a serious

disadvantage, as employers claim that it can be easily overcome by employing foreign sub-foremen who have been in this country long enough to acquire a smattering of the language. Judging from the opinions expressed by foremen and superintendents in the plants visited, the untrained immigrant seems to be admirably suited to the requirements of these industries. As a consequence they offer but few opportunities for employment to boys of American birth. Among the skilled occupations a higher proportion of Americans is found, made up largely of hold-overs from an earlier period when the labor force was recruited from the native born population to a much greater degree than at present. A few American boys were found in the offices and as apprentices to skilled trades in the repair and maintenance deaprtments.

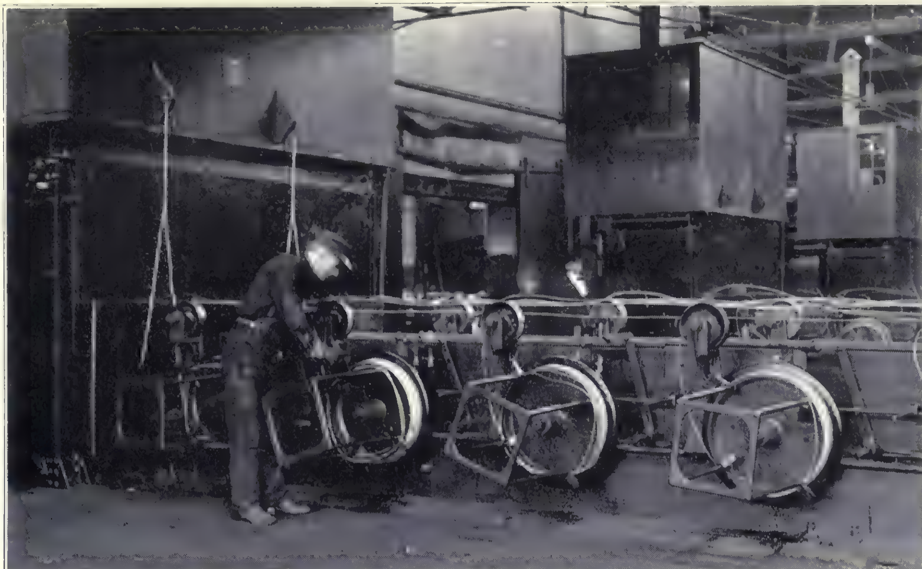
The Working Day and Week

The average working day and week throughout the whole group of industries is longer than in any other branch of manufacturing. Twelve hours constitutes the working day in nearly all the blast furnaces, steel works, blooming mills, and rod mills. Some of the Bessemer converting plants work three shifts a day of eight hours each. As the plants are in continuous operation, half of the time must be put in on the night shift. The usual working week ranges from 72 to 84 hours. One of the largest companies in the city requires every man in its employ to take one day's

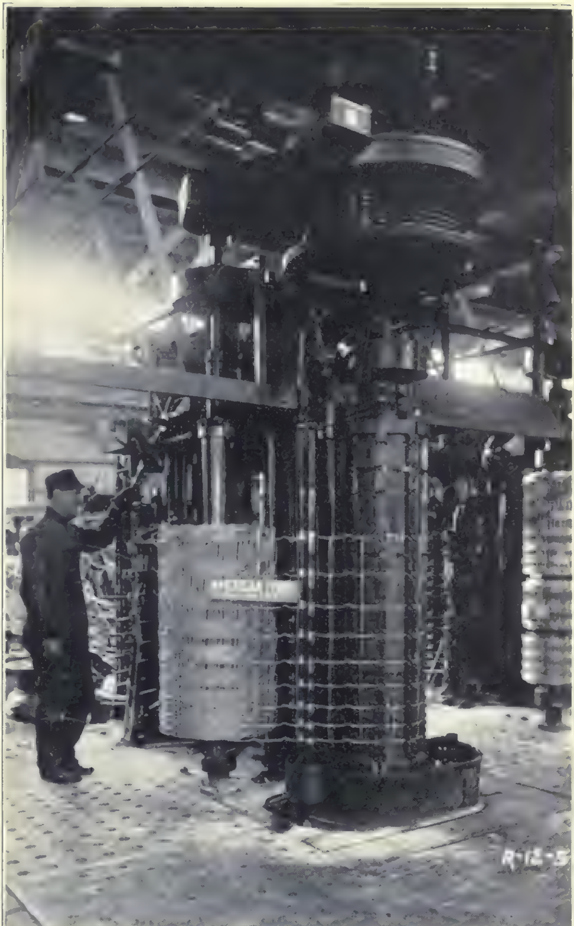
rest for every six consecutive days of work. The plants continue to run on Sundays, but a schedule of rest days has been worked out giving every man one day off each week. Foremen and superintendents in these mills expressed the opinion that the men show a higher working efficiency since the change was adopted. In some of the plants where the six-day week has been proposed but not adopted, the employees declared unanimously against it on the ground that it would mean a serious reduction in their weekly earnings.

As a usual thing the time spent in the mill each day is somewhat longer than 12 hours. The work is dirty and hot, so the men must reach the plant early enough before work begins to allow time for changing clothes. As there is no shut-down at the end of the shift, the men must be on the job when the whistle blows, ready to take the places of those leaving without an instant's delay. At the end of the shift 20 or 30 minutes are consumed in washing up and changing clothes, making the total time in the mill about 13 hours. Add to this an hour a day for going to and from work, two hours for meals, dressing, etc., eight hours for sleep, and the day is complete. It is not surprising that even the high earnings in some of these occupations are not sufficient to attract the average American young man accustomed to somewhat less arduous standards of work and living.

The usual working day in wire and nail mills is between 10 and 11 hours, and in bolt and nut factories, 10 hours. In some of the plants the day shift works



Furnaces for annealing wire. The process is continuous, the wire being wound from one set of reels to another, and passing through the furnace in transit



Woven wire fence machine

10 hours a day for six days, or 60 hours for the week, and the night shift five nights of 13 hours each, or a total of 65 hours a week.

Wages

On a basis of weekly earnings the wages in steel works and rolling mills compare favorably with those paid in other metal industries. A comparison of weekly earnings of male employees over 18 years of age in this group with those paid in the three other largest metal industries is shown in Diagram 5. This comparison is based on wage statistics for 1914 collected by the Ohio Industrial Commission. With respect to the proportion of wage-earners receiving $25.00 a week and over, steel works and rolling mills rank second among the six industries compared, and blast furnaces third. The long working day and week make for high total earnings.

Weekly wages do not tell the whole story, however, because this measure of wages takes no account of the length of time required to earn a given amount. A rougher in a rod mill and a hand compositor in a printing establishment, for example, earn approximately the same wage per hour. But the compositor works only eight hours a day, or 48 hours a week, while the rougher's working day is 12 hours and his working week either 72 or 84 hours, depending on whether or not he works Sundays. This difference in the length of the working week brings the rougher's total earnings up to approximately $30.00, as against

the compositor's earnings of $20.00. The rougher makes $10.00 more than the compositor, but for this advantage in weekly income he puts in 24 hours more of working time.

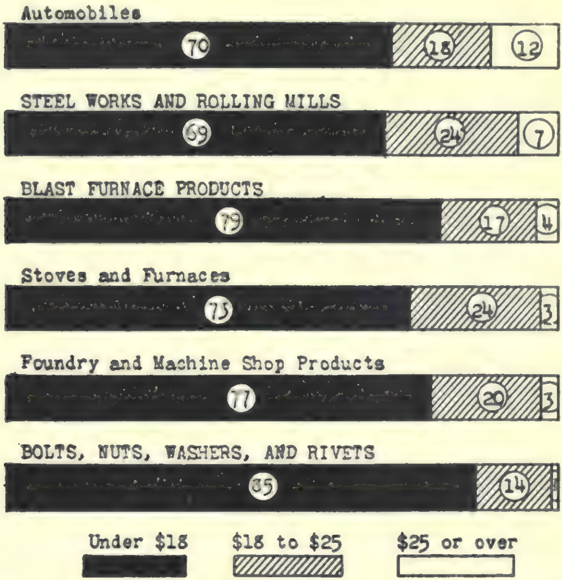


Diagram 5.—Per cent of men over 18 years of age earning each class of weekly wages in six of the principal metal industries in Cleveland

Another factor which favors high earnings is the system of payment. Nearly all the operating force is paid on the tonnage or piece basis, that is, in proportion to the output per day. This system constantly stimulates the men, and some of them make

very high wages. From $10.00 to $12.00 a day is not uncommon for rollers. Finishers frequently earn from $8.00 to $10.00 a day and catchers from $6.00 to $8.00.

Considering the amount of experience and knowledge required in the majority of the operating jobs in wire and nail mills the wages are relatively high. In several of the mills visited the wire drawers earned more than the machinists in the repair departments. A superintendent who was questioned as to the reason for this attributed the wire drawers' high wages to the heavy character of the work and exposure to accidents. Table 14 shows a comparison of the wages paid several classes of wire and nail mill operators, with those received by skilled workmen employed in the maintenance and power departments.

TABLE 14.—WAGES OF OPERATORS AND SKILLED ARTISANS IN WIRE AND NAIL MILLS, CLEVELAND, 1915

Average earnings per hour	Operating departments	Maintenance and power departments
30 cents	Fence machine operators	Pipe fitters
31 "	Nail machine operators	Carpenters
32 "	Tinners and galvanizers	Blacksmiths
32 "	Coarsewire drawers	Stationary engineers
33 "	Finewire drawers	Machinists

There is no doubt that the operator's work is harder, and his surroundings generally less comfortable than those of workers in the machine shop or engine room. He is more likely to be laid off during slack periods, and half of each month must be worked on the night

shift. Against these disadvantages must be balanced the fact that his apprenticeship period is much shorter and the requirements of his job as to skill and knowledge much lower than those in the mechanical trades, while his earnings are approximately the same.

The 1914 report of the Industrial Commission gives separate wage data for bolt and nut factories only for such establishments as are not connected with steel works and rolling mills. Of the men employed in these establishments less than two per cent earn as much as $25.00 a week, and less than 14 per cent from $18.00 to $25.00 a week. Several hundred women are employed in packing departments of nail mills and bolt and nut factories and a few establishments use women on minor machine operations. Such work is relatively unskilled and pays low wages. In 1914 over 78 per cent of the women in the bolt and nut factories and over 50 per cent of those employed in steel works and rolling mills earned less than $8.00 a week.

Table 15 shows the average wage per hour in each occupation. These averages are only approximately accurate, for in order to secure exact wage data for industries which pay by the piece system it would be necessary to make a careful study of payrolls. Since the data presented in the table were collected, the largest corporation in the city, employing about three-fourths of the workers engaged in these industries, has increased the pay of all its employees 10 per cent.

TABLE 15.—APPROXIMATE AVERAGE WAGE PER HOUR IN VARIOUS IRON AND STEEL INDUSTRIES, CLEVELAND, 1915

Blast furnaces	Cents
Blowers	37
Blowing engineers	33
Top fillers	32
Ore bridge operators	25
Keepers	24
Stove tenders	23
Larry men	23
Skip operators	23
Blowing engineers' assistants	22
Cagers	22
Water tenders	22
Weigh bosses	22
Pig machine bosses	22
Keeper's helpers	21
Pig machine men	21

Bessemer steel converters	Cents
Vesselmen	70
Blowers	60
Stopper setters	55
Steel pourers	50
Vesselmen's helpers	45
Ladle liners	40
Regulators, first	36
Regulators, second	31
Stopper makers	30
Bottom makers	28
Ladle liners' helpers	25
Bottom makers' helpers	22
Mold cappers	22

Open hearth steel converters	Cents
Melters	61
Melters' helpers, first	43
Steel pourers	37
Charging machine operators	33
Ladle cranemen	32
Nozzle setters	32
Melters' helpers, second	28
Ingot strippers	27
Melters' helpers, third	25
Nozzle setters' helpers	25
Bottom cast men	25
Stock cranemen	24

Blooming mills	Cents
Rollers	55
Heaters	50
Manipulators	30
Shearmen	30
Cranemen	30
Bottom makers	27
Heaters' helpers	24
Shearmen's helpers	22
Bottom makers' helpers	21

Rod mills	Cents
Rollers	75
Finishers	60
Heaters	49
Roughers	45
Bulldoggers	45
Catchers	45
Furnace men	37
Shearmen	28
Heater's helpers	26
Reel men	25
Snappers	23
Hookers	23
Take-off men	22
Weighmen	21
Rackmen	20
Cranemen	20
Inspectors	20

Wire mills	Cents
Finewire drawers	33
Coarsewire drawers	32
Adjusters	32
Tinners and galvanizers	32
Fence machine operators	30

TABLE 15—(*Continued*)

	Cents
Cleaners	24
Gaugers	24
Wire handlers	22
Reel makers	22
Fence machine operators' helpers	22
Barbed wire machine operators	21
Reel men	21
Inspectors	20
Nail mills	
Nail machine operators	31
Nail inspectors	27
Set-up men	25
Nail operators' helpers	23
Bolt, nut, and rivet factories	
Hot headers	35
Hand rod headers	35
Hot nut pressers (hot forged)	35
Cold headers	32
Turners	30
Cold nut pressers (automatic)	30
Continuous headers	27
Inspectors	27
Pointers and threaders (automatic)	25
Cold nut pressers (hand)	25
Trimmers	22
Nut tappers (automatic)	22
Pointers and threaders (large work)	22
Drillers and tappers	22
Semi-finishers (case hardening)	22
Reamers	22

Regularity of Employment

The proportion of time lost through irregularity of employment is practically the same throughout the group with the exception of blast furnace operation, where it ranges somewhat higher. A comparison of the relative average unemployment in various of the principal industries is shown in Diagram 6, in which each bar represents the highest number employed in 1914 and the portion in outline the average number employed.

Data relating to fluctuation of employment in 1914 are only approximately representative for the iron and steel industries, owing to the period of business depression that immediately followed the outbreak

of the European war. It is probable that data covering a normal year would show somewhat steadier conditions of employment.

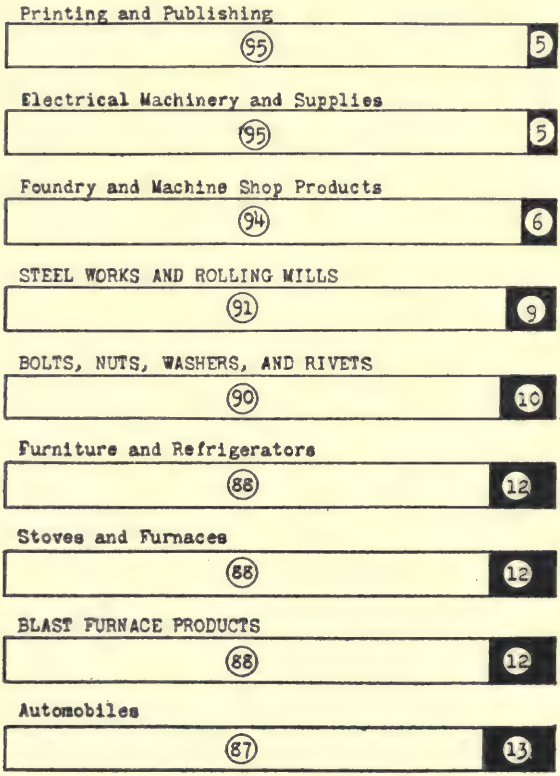


Diagram 6.—Sections in outline represent average percentage of men employed and sections in black average percentage of men unemployed during the year in each of nine large industries in Cleveland

Time Required to Learn

No regular apprenticeship is served in any of these occupations. As a rule, the beginner starts in as a laborer or helper and picks up a knowledge of the work by observation and practice. Estimates of the approximate time required to learn the work well enough to earn average wages in each occupation are given in Table 16. These estimates are based on the statements of foremen and superintendents. Naturally the length of time will vary with the ability of the worker. It must be understood also that these estimates do not mean that the learner will always reach the average wage in the time given. If he is employed in a rod mill where there are but two rollers, he will have to work in subordinate positions until one of them gets promoted, resigns, or dies before he can become a roller, no matter how well qualified he may be for the job. In other words, ability must wait for opportunity, and in the better paid positions the waiting period is likely to be much longer than the learning period.

Opportunities for Promotion

In a general way the opportunities for promotion to good wages are shown in Diagram 5 on page 114, which gives the proportion earning from \$18 to \$25 a week and \$25 a week and over. On this basis the steel works and rolling mills make a good showing. Blast furnaces and bolt and nut factories rank third and sixth respectively among the six industries compared.

TABLE 16.—ESTIMATED TIME REQUIRED TO LEARN THE DIFFERENT OCCUPATIONS IN VARIOUS IRON AND STEEL INDUSTRIES WELL ENOUGH TO EARN AVERAGE WAGES

Blast furnaces	
Blowers	3 years
Blowing engineers	Licensed
Ore bridge operators	6 months
Keepers	6 "
Pig machine bosses	1 month
Weigh bosses	1 "
Water tenders	1 "
Cagers	1 "
Skip operators	1 "
Larry men	1 "
Top fillers	2 weeks
Pig machine men	1 week
Keeper's helpers	1 "
Blowing engineer's assistants	1 "
Stove tenders	1 "
Bessemer steel converters	
Vesselmen	3 years
Blowers	3 "
Stopper setters	2 "
Steel pourers	2 "
Ladle liners	2 "
Regulators, first	2 "
Vessel men's helpers	1 year
Regulators, second	1 "
Stopper makers	1 "
Bottom makers	1 "
Ladle liners' helpers	1 month
Bottom makers' helpers	1 "
Mold cappers	1 "
Open hearth steel converters	
Melters	3 years
Melters' helpers, first	2 "
Steel pourers	2 years
Charging machine operators	1 year
Ladle cranemen	1 "
Nozzle setters	1 "
Melters' helpers, second	6 months
Ingot strippers	3 "
Stock cranemen	3 "
Melters' helpers, third	1 month
Nozzle setters' helpers	1 "
Bottom cast men	1 "
Blooming mills	
Rollers	3 years
Heaters	2 "
Manipulators	1 year
Shearmen	1 "
Cranemen	6 months
Bottom makers	6 "
Heaters' helpers	2 "
Shearmen's helpers	1 month
Bottom makers' helpers	1 "
Rod mills	
Rollers	5 years
Finishers	4 "
Heaters	4 "
Roughers	3 "
Bulldoggers	3 "
Catchers	3 "
Furnace men	1 year
Shearmen	3 months
Heater's helpers	1 month
Reel men	1 "
Hookers	1 "
Cranemen	1 "
Inspectors	1 "
Rackmen	1 week

TABLE 16—(*Continued*)

Weighmen	1 week
Take-off men	1 "
Snappers	1 "
Wire mills	
Adjusters	2 years
Finewire drawers	6 months
Tinners and galvanizers	6 "
Fence machine operators	6 "
Inspectors	6 "
Cleaners	2 "
Barbed wire machine operators	1 month
Coarsewire drawers	6 weeks
Gaugers	6 "
Fence machine operators' helpers	6 "
Wire handlers	1 week
Reel makers	1 "
Reel men	1 "
Nail mills	
Nail machine operators	2 months
Nail inspectors	2 "
Set up men	1 month
Nail operators' helpers	1 week
Bolt, nut, and rivet factories	
Continuous headers	1 year
Nut tappers (automatic)	1 "
Turners	10 months
Cold headers	9 "
Cold nut pressers (automatic)	9 "
Cold nut pressers (hand)	9 "
Trimmers	9 "
Hot headers	6 "
Hand rod headers	6 "
Hot nut pressers (hot forged)	6 "
Inspectors	6 "
Pointers and threaders (automatic)	1 month
Pointers and threaders (large work)	1 "
Drillers and tappers	1 "
Semi-finishers (case hardening)	3 weeks
Reamers	3 "

In all these industries the manufacturing unit is large, with the result, as in automobile manufacturing, that the number of men required for such positions as foremen and superintendents is relatively small. The ratio of supervisory and executive employees in steel works and rolling mills to the number of wage-earners is about one to 48. Diagram 4 on page 93 offers a comparison on this basis of five of the largest metal working industries.

Conditions similar to those in the steel works and rolling mills are found in wire and nail mills and bolt and nut factories. Very few of the establishments employ less than 500 men. Those visited by members of the Survey Staff averaged over 900, with approximately 42 wage-earners to each foreman or superintendent.

Trade Union Organization

At the present time the influence of the labor unions in determining wages and working conditions in these industries is negligible. The fact that the working force is made up so largely of immigrant labor drawn from a number of foreign countries, with as many different languages, makes the problem of union organization a very difficult one. The outlook for trade unions among workers of this type is not promising.

Health Conditions

Health conditions in these industries have improved greatly during the past few years through the greater attention given to the health and comfort of the workers in the design and construction of plants, the installation of sanitary and ventilating devices, and the improvement of machinery. In blast furnaces and open hearth plants workmen are daily exposed to intense heat for considerable periods of time. In rod mills the work is so exhausting that two crews of men who relieve each other at intervals of from 20 to 30 minutes are required. The cleaners in wire mills

work in an atmosphere permeated by steam and acid fumes. The noise from the machines in nail mills is so deafening that many of the operatives keep their ears stuffed with cotton. On the other hand, the appearance of the men in the plants visited was, with a few exceptions, good, and employers show a genuine interest in improvements that make for better health conditions.

Accident Risks

The element of danger from accident is always present in manufacturing work conducted in large units and at high speed. The material itself is a constant source of danger until it is far enough reduced in size to be worked cold. Handling molten metal in lots of 30 or 40 tons, or guiding red-hot rods through a rolling mill at the rate of 30 miles an hour is no child's play, and accidents are frequent. Such work is inherently dangerous, although the number of accidents has been reduced through the introduction of automatic machinery and safety devices. Minor accidents are not uncommon in nail and wire mills and bolt and nut factories, but the risk is probably not much greater than in other lines of manufacturing in which machinery is utilized on a large scale.

The Problem of Training

Prevocational training for occupations in these industries need not be considered so long as the composition of the working force remains unchanged.

Very few boys from the public schools are likely to seek employment in them. If the European war results in a reduction of the supply of foreign labor, the mills will be forced to recruit to a much greater extent than at present from the native population. A study of the present sort, however, must base its conclusions on existing facts rather than on future contingencies. The facts are that in recent years the iron and steel industries have drawn their labor supply from abroad, and they will continue to do so as long as that source of supply is available. There remains then to consider the possibilities of vocational training for workers now in employment.

The special skill and knowledge required in many of the occupations can be obtained only through actual working experience. This is true to a marked extent even of executive and directive positions. A thorough grounding in technical theory is of advantage, but it will not enable the beginner to escape a long and arduous apprenticeship in the mills before he can compete with others of much inferior educational equipment, who have picked up what they know through a long period of hard work on the job. The factory organization, together with the strenuous working conditions, tends to eliminate the artificial advantages enjoyed by the educated man in many lines of employment. The considerable nummer of men who, with the scantiest educational preparation, have risen from the ranks to the better positions indicates the importance of practical experience as a factor in advancement.

This is true to a still greater degree of the level immediately below supervisory and managerial work. Bessemer blowers, vesselmen, keepers, finishers, catchers, roughers, heaters, first and second melters, steel pourers, can obtain only in the mills the knowledge, skill, and judgment necessary for efficient and remunerative service. In certain kinds of work performed at high speed and under dangerous conditions, efficiency and safety depend on the development of a kind of sixth sense which, without conscious effort on the part of the worker, enables him to do exactly the right thing at exactly the right time. The work deals with such large units that its very momentum forces a complete adaptation of his efforts to the mechanical and chemical processes taking place. This ability, which makes up a large part of what we may call the technique of the work, can be acquired only under working conditions.

Directly related training for the semi-skilled occupations is out of the question, because the work has been so simplified that the technical content is reduced to a minimum, and because the factories are organized to teach what little is needed in the shortest possible time at the least possible expense. As a rule not even the ability to read English is required, and if the operator knows enough arithmetic to count and to read the numbers on a specification tag, he has about all the mathematics his job demands.

A knowledge of English, although not essential for the work itself, is of real importance from the standpoint of convenience and safety. Much of the work

is dangerous, and in all of it there is the risk of infection from burns or cuts received in handling metal stock. The fact that many of the operators do not understand or read English renders it difficult to warn them against danger and instruct them as to the care and disinfection of wounds in case of accidents. The teaching of English would be of real value to all the foreign workers and represents practically the only training possible that can be said to have vocational significance.

The principal obstacles to the organization of English classes for the foreign workmen in the mills are the long working day and the fortnightly change of shift. A 12-hour working day leaves little time or energy for evening classes. This objection does not hold in the case of those employees who work a shorter day, but the difficulty of altering the hours for instruction from day to night, or vice-versa, every two weeks as the shift changes, will be at once apparent. While these conditions remain unchanged little can be done, and in any case continuation instruction for workers in these industries must be limited in the main to the teaching of English, accident prevention, and personal hygiene.

Summary

1. The group of industries here considered ranks first in the city with respect to the total value of manufactured products, and third as to number of wage-earners.

2. The proportion of skilled men in the working force is very small.
3. The occupations fall into four classes: supervisory positions below the grade of superintendents and assistants; occupations in whch the employee does part of the work while directing a crew of helpers; operating jobs demanding strength, agility, endurance, or dexterity, rather than technical knowledge; and machine operating and tending. The bulk of the positions are in the last class.
4. Machine operating may be divided into continuous machine operating, in which the work is light, constant, and monotonous; and intermittent machine operating, in which the work is usually heavy, but broken up by frequent periods of comparative inaction.
5. Between 80 and 90 per cent of the working force is composed of immigrant labor.
6. The usual working day in blast furnaces and steel mills is 12 hours, the working week from 72 to 84 hours. In nail and wire mills, and bolt, nut, and rivet factories the usual working day is from 10 to 11 hours.
7. Wages, if compared on a weekly basis, average higher than in many other industries, due to the long working day and week. A comparison of hourly wages makes a much less favorable showing.
8. High wages are paid for extensive knowledge and experience in mill operation, strenuous physical labor under exposure to great heat, or for work in which the risk of accident is considerable.

9. The wages paid for several kinds of semi-skilled machine operating are equal to those of the skilled mechanics employed in the power and maintenance departments.
10. The time lost through irregularity of employment is small as compared with that in other industries.
11. Only a small proportion of the workers are organized.
12. No apprenticeship term is required in any of the occupations outside of the mechanical trades in the power and maintenance departments.
13. The chance of promotion to high pay is approximately the same as in other metal industries. Promotion to salaried directive and supervisory positions is infrequent on account of the relatively small number of men required for such work as compared with the number of wage-earners.
14. No pre-vocational school training need be considered, for the reason that very few boys from the public schools will enter these industries.
15. In practically all of the occupations both theory and practice must be learned in actual employment.
16. Many of the foreign workmen would be benefited by instruction in English, accident prevention, and personal hygiene.
17. The principal obstacles to the organization of night classes for giving such instruction are the long working day and the night shift.

CLEVELAND EDUCATION SURVEY REPORTS

These reports can be secured from the Survey Committee of the Cleveland Foundation, Cleveland, Ohio. They will be sent postpaid for 25 cents per volume with the exception of "Measuring the Work of the Public Schools" by Judd, "The Cleveland School Survey" by Ayres, and "Wage Earning and Education" by Lutz. These three volumes will be sent for 50 cents each. All of these reports may be secured at the same rates from the Division of Education of the Russell Sage Foundation, New York City.

Child Accounting in the Public Schools—Ayres.
Educational Extension—Perry.
Education through Recreation—Johnson.
Financing the Public Schools—Clark.
Health Work in the Public Schools—Ayres.
Household Arts and School Lunches—Boughton.
Measuring the Work of the Public Schools—Judd.
Overcrowded Schools and the Platoon Plan—Hartwell.
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The Public Library and the Public Schools—Ayres and McKinnie.
The School and the Immigrant.
The Teaching Staff—Jessup.
What the Schools Teach and Might Teach—Bobbitt.
The Cleveland School Survey (Summary)—Ayres.

Boys and Girls in Commercial Work—Stevens.
Department Store Occupations—O'Leary.
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Railroad and Street Transportation—Fleming.
The Building Trades—Shaw.
The Garment Trades—Bryner.
The Metal Trades—Lutz.
The Printing Trades—Shaw.
Wage Earning and Education (Summary)—Lutz.